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NAVPERS 93020A

GUNNER'S MATES SCHOOL CLASS "A"

STANFORD UNIVERSITY
JUL 1966
GOV'T DOCUMENT DIVISION

TRAINEE'S GUIDE

MARCH 1966

BUREAU OF NAVAL PERSONNEL

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CLASS "A"

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TRAINEE'S GUIDE

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BUREAU OF NAVAL PERSONNEL

DEPARTMENT OF THE NAVY
BUREAU OF NAVAL PERSONNEL
WASHINGTON, D. C. 20370

TRAINEE'S GUIDE
GUNNER'S MATES SCHOOL CLASS "A" COURSE, NAVPERS 93020A

1. This publication has been prepared for use as a text in the Gunner's Mates School Class "A" course. The Instructor's Guide, NavPers 93019A, has been prepared as a companion publication.

2. Corrections and recommended changes to this publication are invited. Commanding Officer, Service School Command, U. S. Naval Training Center, Great Lakes, Illinois, is hereby assigned clearing house responsibility for evaluating and compiling recommended improvements and for submitting them to the Chief of Naval Personnel in the form of a proposed change to the publication. Proposed changes shall be submitted to the Chief of Naval Personnel during the third quarter of each fiscal year, or more often if deemed necessary. Activities using this course material are requested to submit their changes directly to the Commanding Officer, Service School Command, U. S. Naval Training Center, Great Lakes, Illinois 60088, with a copy to the Chief of Naval Personnel (Attn: Pers-C126). No deviations from this curriculum are authorized until approved by the Chief of Naval Personnel.

3. This publication supersedes NavPers 93020, dated January 1964.

G. M. METZE
Captain, USN
Director, Weapons System
and Fleet Training Division

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SAFETY NOTICE

General:

To avoid casualties, the observance of the following safety rules is mandatory. The Bureau of Naval Weapons shall be informed of any circumstances that conflict with these safety precautions or of safety precautions which for any reason require changes or additions.

When the exact meaning of a safety precaution is doubtful, an interpretation shall be requested from the Bureau of Naval Weapons. If conditions not covered by these safety precautions should arise which, in the opinion of the commanding officer, could render further operation of the equipment unsafe, none of the existing safety precautions shall be interpreted as authority for performance of further operations.

Since familiarity with any equipment, no matter how dangerous it may be, is apt to lead to carelessness, all persons who supervise or perform work on weapons or weapon systems shall exercise the utmost care that all regulations and instructions be rigidly observed and shall constantly supervise the personnel working under their supervision, reminding them frequently of the necessity of observing the safety rules in the performance of their work. NO RELAXATION OF VIGILANCE SHALL EVER BE PERMITTED.

To prevent possibility of accidents, the safety devices provided shall always be used as designated and shall be kept in proper operating condition. All instructions promulgated by competent authority regarding the use of these devices shall be strictly observed.

Changes and modifications of or additions to ordnance equipment shall not be made without explicit authority from the Bureau concerned.

Moving Equipment:

All personnel whose duties involve the operation of moving ordnance equipment shall be thoroughly familiar with the safety precautions applicable to and the operational instructions for that equipment.

Except at general quarters, a safety watch shall be posted on all power equipment that is capable of inflicting injury to personnel or material and is not continuously visible to the controlling station. The safety watch and controlling station shall have telephone or other effective voice communications established before any operation of the equipment is attempted.

All personnel taking part in or observing the operation of power equipment shall remain alert and keep clear of moving parts. At no time will skylarking be allowed in the vicinity of operating power equipment.

Electrical:

A large number of electrical casualties are due mainly to sheer carlessness; therefore it is important that all personnel be warned of the dangers of electrical shock. All persons authorized to repair or maintain electrical equipment must be constantly aware of the urgent need to be alert and must be cautious in carrying out their duties.

Since weapon systems employ voltages up to 440 volts which are extremely dangerous, only authorized personnel who have been duly assigned for system upkeep shall work on this equipment.

Whenever possible, the main supply and power switches shall be turned off and tagged before checking or overhauling an electrical circuit. When electrical equipment has to be serviced or adjusted with the power covers removed and the circuits energized, the following safety rules shall be observed:

1. Always work in the presence or with the assistance of another person who is capable of rendering first aid.

2. Remove rings, wrist watches, bracelets, and other metal items.

3. Do not change fuses or lamps in power panels when the electrical circuits are energized.

4. When making adjustments, use only tools with adequately insulated handles.

5. Keep hands, clothes, and shoes dry.

6. Insure good insulation from ground with some suitable nonconducting material, such as dry wood, several layers of dry canvas, or rubber mats of approved construction.

Under certain conditions, dangerous voltage potentials may exist in circuits even after the circuits have been deenergized, due to the capacitors which retain their charge. These circuits can be discharged by grounding them. Remember: ALWAYS CHECK AN ELECTRICAL CIRCUIT WITH A VOLTMETER TO INSURE THAT THE CIRCUIT IS OPEN.

Electrical safety precautions shall be posted on or near each group of electrical or electronic equipment. Specific safety precautions pertaining to electrical equipment are contained in U. S. Navy Ordance Safety Precaution, OP 3347 and in NAVSHIPS 250-000, Chapter 9670 (old Chapter 67).

A thorough knowledge of the currently prescribed methods for administering artificial respiration to victims of electrical shock is essential. NAVMED P5056 describes the correct methods of resuscitation.

Explosive Ordnance:

Missiles, as well as gun ammunition, bombs, rockets, and torpedoes, are extremely dangerous; therefore constantly vigilance and intelligent supervision must be exercised during handling and storage of missiles and missile components.

Missile boosters shall be handled with extreme care. A slight blow may crack the propellant grain and cause an explosion when the weapon is fired. Care shall be taken that no heat is applied to or near boosters.

Missile warheads are classified as bomb type ammunition; therefore all general safety precautions for handling high explosive and bomb type ammunition shall be exercised when warheads are being handled. Since warheads become dangerous when their temperature reaches 170° F., they must not be unnecessarily exposed to direct sunlight.

Handling of missiles and missile components shall be kept at a minimum. Live missiles shall never be used to check out the equipment.

HOW TO USE YOUR TRAINEE'S GUIDE

Gunner's Mates School Class "A" Course, Trainee's Guide:

This Trainee's Guide has been prepared for your use during the course of instruction and your future duty assignments. It does not supersede any other publication.

Other Publications:

The reference publications pertaining to the individual topics are listed, under the appropriate subheading, on the first page of each topic. To derive maximum benefit from this course of instruction, conscientiously study all assignments.

Many topics also include an optional reading list. The reading of the material listed under this subheading is not compulsory, and the publications listed may not always be available for classroom use; the optional reading list is primarily included for reference you will need in the future.

Presentation of Course Material:

The course material has been divided into sections and topics in which the material is presented in logical sequence. The training goals and skills to be acquired are usually stated at the beginning of each topic and provide a means for checking your progress before you proceed to the study of the next topic.

At the end of each section there is a page to be used for classroom notes. The accuracy of your notes will be checked by the instructor after completion of each section.

Quiz Sheets:

Quiz sheets are included at the end of each section or in the reference material. The answers to the questions may be found in the corresponding section of the Trainee's Guide or in the applicable reference material. The quizzes are provided to enable you to check your own progress in studying the course material.

Written and Performance Tests:

Written and performance tests will be conducted throughout the course of instruction. The tests will be administered by the instructor for his evaluation of your progress.

Safety Precautions:

A safety notice has been included in the front matter of this Trainee's Guide. This notice contains general safety precautions and instructions applicable to personnel associated with weapon systems. Furthermore, specific safety precautions are included wherever required in the text. Read these instructions carefully and develop safe working habits that will insure not only your own safety, but also the safety of all those working with you.

TRAINEE'S GUIDE
FOR
GUNNER'S MATES CLASS "A" COURSE

NAME________________________________

SERIAL NO.___________________________

GM SCHOOL___________________________

CLASS NO.___________________________

RECORD OF CHANGES

Number or Description of Change	Made by	Date

Section 1

WEAPON SYSTEM ORIENTATION AND FUNDAMENTALS

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Introduction	2
2.	Weapon System Concept	4
3.	New Developments in Weapon Systems	6
4.	Fundamental Concepts	10
5.	Identification and Care of Ordnance Equipment	24
6.	Documentation	30
7.	General Safety Precautions	34

TOPIC 1: INTRODUCTION

You Are Now Going To Learn:

1. The mission of the weapon systems.
2. Why you were selected for this course.
3. The duties of a gunner's mate.
4. The scope of the course.
5. Methods that will be used to evaluate progress of trainees.

Discussion Points For This Topic Are:

1. Introduction.
2. Qualifications.
3. Weapon systems.
4. The duties of a gunner's mate.
5. Scope of the course.
6. Evaluation of trainee's progress.
7. Review and summary.

INFORMATION AND DISCUSSION:

The Staff welcomes you to the Gunner's Mates School. We wish you success as you embark on the second phase of your Naval career.

The Navy is constantly improving its many training programs, in order to keep pace with modern technical advancements.

Your ability to adapt yourself to Navy life and to meet the Navy's high standards of performance is a credit in itself.

During the early days of your training, you learned that the mission of the Navy is to control the seas. To accomplish this mission, the Navy depends on her weapon systems and the gunner's mates who maintain and operate them.

It's true that all ratings in the Navy are important and that team work is essential. The gunner's mate, however, should have more pride than all others in his work, because all Navy ratings are auxiliary to the rating of gunner's mate.

The gunner's mate of today is expected to maintain and to operate the weapon systems which are results of America's most advanced scientific research and development and precision-products of American ingenuity and industry.

You were selected for training not by chance; your high standing in mathematics, your excellent ability to learn, and your other outstanding qualities earned you the privilege of attending this course. You will learn about basic machines, hydraulics, electricity, and electronics. This is the only course offered by the Navy where a man simultaneously studies so many technical subjects.

This course of instruction will be presented in the order listed in this Trainee's Guide, which you are going to have with you throughout the course.

Your progress will be evaluated by using written quizzes, written examinations, and by your performance. A Navy man's marks constitute a very important part of his service record; they are a decisive factor in determining his selection for advancement in rating, for future assignments to ships, and for the Navy's more advanced courses.

If you find that your knowledge of a particular subject is deficient, discuss the problem with your instructor. His background and experience will prove beneficial to you. Also, if you feel that you will benefit from additional study, do not be hesitant to request additional instructions.

Upon graduation from this course, you will be expected, with proper instructions from and under supervision of senior petty officers, to maintain and operate all weapon systems to which you are assigned.

The Staff of this school places its confidence in you and is ready to assist you with all your problems.

TOPIC 2: WEAPON SYSTEM CONCEPT

You Are Now Going To Learn:

1. Evolution of naval weapons.
2. Elements of a weapon system.
3. Requirements of weapon systems.

Discussion Points For This Topic Are:

1. Guns.
2. Gunpowder.
3. Fire control.
4. Weapons in general.
5. Elements of a weapon system.
6. Requirements of a weapon system.
7. Review and summary.

INFORMATION AND DISCUSSION:

Near the middle of the thirteenth century, Friar Roger Bacon of England gave the Western World of that time the first effective formula for gunpowder.

Also in the thirteenth century, Friar Bertholdus, nicknamed "The Black," of Freiburg, Germany, discovered the principles of the gun.

However, for a long time after the invention of the gun, people argued whether bows or guns were more efficient: A crossbow bolt could penetrate a knight's armor, but the bullet of an early gun could not; also the archer with the long bow could shoot several times while the gunner was loading and firing a single round.

Until less than two hundred years ago, naval guns were still fired at point-blank range. Fire control was mainly a matter of skillful seamanship. The captain of the ship had to maneuver his vessel within shooting distance of the enemy to make a hit probable.

The major factor in the development of the science of gunnery is war, since every war necessitates not only the development of new weapons, but also the improvement and adaptation to new uses of already existing weapons.

The continuous improvements of gun propellants have greatly increased the lethal range of our present-day guns. However, the improvements of gun ranges can make the guns more effective only if the guns are adequately controlled.

The evolution of gun-fire control began in the ninetheenth century with the invention of fixed sights and continued with the development of movable sights. The telescopic sight was introduced in the 1840's.

The most important fire control innovation was radar, which opened the door to new possibilities in naval warfare. Radar was also one of the main contributing factors to the enormous accent placed on electronics.

The following is a list containing brief descriptions of guns and other weapons used in the Navy:

Guns:

A typical gun consists of a tube, closed at one end, from which a projectile is fired by burning a propellant charge in an enclosed space. Guns are general purpose weapons used against surface ships, aircraft, shore installations, and enemy personnel.

Rockets:

Rockets are selfpropelled weapons and particularly suited for firing from small craft and airplanes because they have no recoil.

Guided Missiles:

Guided missiles are fairly new weapons. They can travel great distances with heavy loads, are selfpropelled, and contain their own guidance system.

Torpedoes:

Torpedoes are selfpropelled underwater missiles used against enemy ships.

Underwater Mines:

Underwater mines are weapons used to hinder enemy ship operations.

Depth Charges:

Depth charges are antisubmarine weapons which are exploded at a predetermined depth or at a certain distance from the submarine.

Bombs:

Bombs are all missiles dropped by aircraft, except guided missiles, torpedoes, and mines.

Chemicals:

Chemicals are toxic materials which can be fired in projectiles from guns or mortars or can be dropped by aircraft.

In today's warfare, the use of just one single kind of weapon cannot be considered effective. To achieve the desired results, a combination of various weapon-types and equipment is essential. To be effective, a weapon system must include the following:

1. Units for detecting, locating, and identifying the target.
2. Units for directing a delivery unit or weapon to the target.
3. Units for initiating delivery of or for delivering the destructive device of a weapon to the target.
4. Units for destroying the target when the target is approached or contacted.

An efficient naval weapon system must possess the following qualifications:

1. Reliability--The system must be capable of functioning continuously under adverse conditions for long periods at specified rates (certain number of rounds fired per minute, number of hits at specified accuracy, etc.).

2. Flexibility--The system must be capable of functioning satisfactorily regardless of the inadequacies of power supplies (such as power fluctuations), mismated parts, or design deficiency. The system may also be required to function satisfactorily with certain components omitted.

3. Safety--The system cannot be made absolutely foolproof; but, wherever possible, hazardous conditions must be eliminated by interlocks or other means, to avoid danger to friendly ships and aircraft or to own ship structure or personnel.

4. Simplicity of Operation--Although basically all modern weapon systems are extremely complicated, they must be designed so that human beings are able to operate them with the minimum of difficulties. These facts are always considered in the design of control arrangement, and in the provision of safe and comfortable operating conditions for the personnel.

5. Maintenance Capability--The system must include long-life components to avoid constant testing, frequent repairs, and replacements of parts, especially where electronic components are involved.

TOPIC 3: NEW DEVELOPMENTS IN WEAPON SYSTEMS

You Are Now Going To Learn:

1. Elements of a missile system.
2. Characteristics of a basic missile system.
3. Requirements of a missile system.

Discussion Points For This Topic Are:

1. Definitions of missiles.
2. Missile guidance.
3. Launcher.
4. Feeder system.
5. Weapon control system.
6. Handling of weapons.
7. Requirements of a guided missile system.
8. Review and summary.

INFORMATION AND DISCUSSION:

A missile is an object that can be projected or thrown at a target. A missile can be a stone or an arrow, as well as a gun projectile, bomb, torpedo, or rocket. The expression "missile" is gradually becoming synonymous with "guided missile." A guided missile is an unmanned vehicle that travels above the earth's surface. It carries an explosive warhead or any other destructive load. A guided missile is self-propelled and capable of being guided or of controlling its own trajectory.

An intercept-aerial guided missile is a more effective device of defense against enemy aircraft than a gun projectile; a missile can intercept attacking aircraft at greater height and longer range than gun projectiles.

The missile guidance system keeps the missile on the proper course to intercept the target. The guidance information may be transmitted by radio or radar from the launching site, from other control points, or from the target itself.

There are several types of missile guidance, and certain missiles require more than one type of guidance. A guidance system picks up guidance information from a certain source, converts the information to a signal to activate control devices, which move the flight-control surfaces (wings or fins) of the missile.

A guided missile launching system is basically composed of the following three major components:

1. Launcher.
2. Feeder system.
3. Weapon control system.

The purpose of a launcher is to support the missile during the last handling stages prior to firing.

The feeder system automatically delivers the weapon (missile/booster combination), in condition for firing, from the ready-service magazine to the power-driven, remotely controlled launcher.

The weapon control system consists of the fire control equipment and weapon direction equipment.

NOTE: Although a gunner's mate will not be required to maintain or operate other equipment than the launcher and feeder systems, he must have some knowledge of the weapon control system in order to participate in teamwork on these missile systems with personnel of other ratings.

The weapon control system on a DLG class ship performs the following functions:

1. Designates specific weapons for engagement with specific targets.
2. Assigns specific directors to specific targets.
3. Assigns the launcher to the appropriate missile fire control radar.
4. Fires single missiles or salvos.
5. Maintains missile guidance.
6. Monitors missiles in flight.
7. Arms BTN-warheads at the appropriate time.
8. Detonates BTN-warheads at the appropriate time.
9. Determines the probable damage to the target.

All missile launching systems have missile handling and stowage equipment. Because of the heavy weights, missile handling requires use of power-driven equipment.

In the future, the fleet will considerably increase the number of its missile launching systems. Therefore you should try every day to improve your performance, since you can look forward to a very interesting and rewarding career in this field.

NOTE: More details about missile systems are provided in Section 19.

QUIZ SHEET:

1. The range of modern guns was increased by the improvements of gun__________.

2. The development of gun fire control began in the ninetheenth century with the invention of________________ and continued with the invention of movable sights.________________

3. The most important contribution to the improvement of fire control was the invention of________________.

4. The first useful formula for gun powder was given to the world in the__________ century.

5. What advantage do rockets have over guns?________________

6. A modern weapon system must have the following qualities:

   a.________________.
   b.________________
   c.________________.
   d.________________.
   e.________________.

7. An effective naval weapon system must include units for detecting, locating, and ________________ the target.

8. Missile control surfaces can be either wings or________________.

9. The three major components of a missile launching system are:

   a.________________.
   b.________________
   c.________________.

10. The weapon control system monitors a missile in flight.

    True__________or False__________.

TOPIC 4: FUNDAMENTAL CONCEPTS

You Are Now Going To Learn:

1. The basic terms applicable to a gunner's mate's rating.
2. The organization of a gunnery department.

Discussion Points For This Topic Are:

1. Ordnance and gunnery.
2. Ballistics.
3. Weapon systems.
4. Glossary of frequently used terms and abbreviations.
5. Organization of gunnery department.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Optional reading list:

      a. NAVPERS 10783A.

INFORMATION AND DISCUSSION:

In this topic you will study the fundamentals of naval ordnance and gunnery applicable to the rating of a gunner's mate.

The terms "ordnance" and "gunnery" pertain to weapons and their use.

Ordnance comprises weapons and equipment associated with weapons. Ordnance is classified as follows:

1. Explosive ordnance.
2. Inert ordnance.

Explosive ordnance includes gun ammunition, missiles, torpedoes, mines, bombs, and rockets.

Inert ordnance includes projecting devices (guns, launchers, and release gears), protective armor, and all equipment required for weapon operation and control. Aboard ship, inert ordnance comprises all elements of ship's armament.

Gunnery is the art and science of using guns. In this Trainee's Guide, however, the term "gunnery" is used in a broader sense and includes also operation and control of all armament elements. Gunnery is principally concerned with the practical use of ordnance equipment.

Ballistics is the science of projectiles in motion. In this Trainee's Guide, unless otherwise specified, the term "ballistics" refers to the motion of projectiles fired from guns.

Ballistics is classified as follows:

1. Interior ballistics.
2. Exterior ballistics.

Interior ballistics is concerned with the motion of the projectile within the bore of the gun.

Exterior ballistics is concerned with the action of the projectile in flight.

A weapon system is a combination of a weapon (or several weapons) and the equipment which projects the destructive part of the weapon (or weapons) against the enemy. This combination enables a weapon to utilize its capabilities to the maximum.

The concept of a weapon system is relatively new and is mostly associated with modern weapons, such as guided missiles; however, certain combinations of weapons with other equipment have already been used in the past, although they were not officially designated as "weapon systems."

The following is a listing of common terms, abbreviations, and definitions which will be frequently encountered in the following text and are applicable to the rating of a gunner's mate.

GLOSSARY

AA: Antiaircraft.

AAC: Antiaircraft common projectile.

AC: Alternating current which periodically reverses the polarity of a circuit. Usually, if the value of a current is plotted on a time graph, the result is a rather smooth sine wave, which is the characteristic output waveform of transformers and AC generators. On ships, AC supplies are normally either 60 or 400 cycles per second.

ACQUISITION: Process of accepting a target designation, acquiring a target, and initiating target tracking.

ADVANCE RANGE: Actual range combined with the corrections and predictions required to compensate for motion of own ship and of target during time of flight, plus ballistic corrections and spots.

A-END: Pump in a hydraulic power drive.

AFTERBODY: Part of a torpedo between its midship section and tail, usually containing propulsion and guidance equipment.

AIMING: Process of establishing target position in train and elevation.

AMMUNITION: Any projectile, or explosive weapon, or its components (not guns or weapon launchers).

AMMUNITION DETAILS: Components of a round.

AMPLIDYNE (GENERATOR): Trade name of a highly responsive, variable output DC generator.

AMPLIDYNE SYSTEM: System in which a small signal regulates the output of a DC amplidyne generator to control a DC drive motor.

ARMING: Setting of fuze to permit initiation. (To prevent initiation, a fuze is unarmed.)

A/S: Antisubmarine (adjective).

ASROC: Antisubmarine rocket (type of A/S weapon).

ASW: Antisubmarine warfare.

AUTOMATIC (AUTO) CONTROL: Complete and direct control of a weapon system by remote signals received from a fire control system.

AUTOMATIC GUN: Case gun in which some of the propellent energy is used to open the breech, to eject the empty case, and to load the next round.

AXIAL-PISTON PUMP: Pump consisting of a barrel which contains a group of cylinders, arranged parallel to the axis of the rotation of the barrel.

AXIS OF BORE: The extension of the central axis of the gun bore. It is tangent, at the muzzle, to the trajectory of a projectile fired from the gun.

BAG AMMUNITION: Gun ammunition with propellant in fabric bags and with separate projectiles and primers.

BALLISTIC CORRECTIONS: Corrections in range and/or deflection, to compensate for existing or possible errors caused by drift, wind, and other variations from standard range table conditions.

BALLISTIC MISSILE: Guided missile designed to follow, for a substantial part of its flight, a ballistic (free or unsteered) trajectory.

BARREL (GUN): Part of gun structure containing the bore.

BASE RING: Base section of rotating structure of gun or rocket mount, also called deep section ring or lower carriage.

BASIC MECHANISMS: Elementary components of machinery, also called basic machines.

BATTERY: Two or more weapons of the same design.

BATTERY ALINEMENT: Alinement of weapons and fire control equipment in accordance with a common system of reference lines and planes, under specified conditions.

BATTLE BILL: Listing of stations to be manned under battle conditions and personnel requirements for manning those stations.

BATTLE CONTROL STATIONS: Key points of a ship's battle organization.

BATTLE TELEPHONE: Sound powered telephone.

BEARING RATE: Rate of change of target bearing from ship, caused by relative motion of ship and target. Bearing rate may be expressed in knots (linear measure) or in degrees-per-minute (angular measure).

BENCH MARK: Reference point on own ship structure used for alining battery directors.

B-END: Hydraulic motor in a hydraulic power drive.

BLACK POWDER: Explosive mixture made of carbon, sulfur, and saltpeter (used as an auxiliary explosive).

BOOSTER: Rocket which furnishes thrust during initial flight phase of a missile.

BORE: Rifled interior part of a gun barrel.

BORESAFE FUZE: Device in the exploder train that prevents a projectile from exploding until it has cleared the muzzle of the weapon.

BORESIGHTING: Adjusting sights to make them parallel with gun-bore axis or to make the lines of sight intersect the gunbore axis at a specified range.

BREECHBLOCK: Gun mechanism element, also called plug, which blocks chamber when gun is fired.

BRISANCE: The shattering effect of a high explosive. The effect is dependent on the rapidity at which an explosive develops its maximum pressure.

BUREAU OF SHIPS TECHNICAL MANUAL: Bureau of Ships publication which contains a technical compilation on shipboard equipment, some of which is related to ordnance.

BURSTER: Bursting charge (or explosive load) in a projectile, mine, torpedo, etc., or final unit in an explosive train.

CALIBER: Unit used for measuring diameter of a projectile or gun bore. Small arms are measured to the nearest hundredth of an inch; large guns are measured in inches or millimeters. Example: In a 5"/38 caliber gun, the gun barrel caliber (diam.) is 5", and the gun barrel length is 5" x 38.

CASE AMMUNITION: Gun ammunition with propellent charge and associated components in metal or plastic cartridge case.

CHAMBER (GUN): Gun part which holds propellent charge just before gun is ready to fire.

CHASE (GUN): Outer tapering forward part of gun barrel.

CIC: Combat Information Center.

CLOSED LOOP SERVO: Servo system consisting of error detecting device, error signal amplifier, and servo motor. The input order signal and the response signal of the servo motor are compared by the error detecting device. The resultant error signal is amplified to rotate the servo motor in proper direction to cancel the error signal.

COM: Common projectile.

COMPLETE ROUND: All ammunition details required to fire one shot.

COSAL: Coordinated Shipboard Allowance List, individually prepared for each ship or activity.

COOL PROPELLANT: Propellant that burns at a relatively low temperature.

COPPER FOULING: Metal residue deposited in gun bore by erosion of rotating bands.

COUNTERBATTERY FIRE: Support fire directed against enemy weapon emplacements.

COUNTERRECOIL: Movement of recoiling gun parts toward battery position, caused by a counterrecoil mechanism or recuperator.

CPS: Cycles per second.

CREEP: Forward movement of fuze parts when the projectile begins to slow down due to air resistance.

CROSSHAIRS or CROSSWIRES: Reticle marks consisting of a pair of perpendicular lines (horizontal and vertical).

CRT: Cathode ray tube.

CYCLONITE: See RDX.

DC: Direct current which does not reverse the polarity of a circuit. This current may fluctuate or may be interrupted, but it always remains a direct current. (See AC.)

DASHPOT: A hydraulic braking mechanism.

DATA TRANSMISSION SYSTEM: Usually an electrical system for transmitting precise data on fire control and navigation.

DEAD TIME: Time interval between fuze setting and firing of gun.

DECKPLANE: A plane parallel to the ship's deck.

DECOPPERING: Process of removing copper fouling from gun bore.

DEFILADE or REVERSE SLOPE FIRE: Gunfire applied to shore targets located behind terrain.

DEFLECTION: Lateral angular correction applied to the target bearing to obtain a correct gun order.

DEGREE OF READINESS: Status of ship's complement, plant, and armament under specified conditions.

DEPTH CHARGE: A/S weapon dropped aft or projected from surface vessel.

DETONATION: Violent chemical action (oxidation and recombination) initiated by a shock which produces a shock wave, heat, and gases.

DETONATOR: Initiating device in an explosive train.

DIFFERENTIAL: (1) CYLINDER: Piston-cylinder (hydraulic device) which develops either equal thrust with unequal pressure or unequal thrust with equal pressure. (2) MECHANICAL: Gear arrangement which adds or subtracts mechanical inputs. (3) SYNCHRO: Either one of the two types of synchros used to obtain a mechanical or electrical difference between or sum of two inputs.

DIRECT FIRE: Gunfire aimed directly at target ashore when target is visible to firing ship.

DIRECTOR: Fire control unit that establishes location of target.

DISPERSION OF SHOT: Distance or impact point of shot from the mean point of impact of the salvo. Dispersion in range is measured parallel to the line of fire; dispersion in deflection is measured at right angles to the line of fire in a horizontal plane.

DOUBLE BASE POWDER: Solid rocket propellant, composed mainly of nitrogylcerin and nitroguanidine.

DOUBLE SPEED SYNCHRO OPERATION: Use of two parallel synchro systems. To achieve greater accuracy, one is usually operating at a 1 : 1 ratio with input, and the other at a 36 : 1 ratio with input.

DREDGER HOIST: Type of ammunition hoist used between ammunition handling rooms.

DRIFT: (1) Deflection of projectile trajectory by interaction of gravity, air resistance, and projectile spin. (2) Rate at which water current moves a ship with respect to land.

DUMMY or DRILL AMMUNITION: Ammunition without explosives or propellant.

ELECTRICAL FIRE: Primer firing by means of electricity.

ELEVATING ARC: Gear sector on slide used to elevate guns.

ELEVATING GEAR: Mechanical, hydraulic, and electrical equipment used to elevate weapons.

ELEVATION: Movement of weapon in a plane perpendicular to the deck, also called pointing.

ELEVATION ALINEMENT: Adjusting of fire control and weapon system elements to make them parallel and at exactly the same angles to a selected horizontal plane.

ELEVATION RATE: Rate of change of target elevation (position angle) in degrees per minute.

EMF: Electromotive force, usually equivalent to voltage.

ENFILADE FIRE: Gunfire applied to target whose long axis is parallel to the line of fire.

EROSION (GUN): Wear inside a gun bore.

ERROR SIGNAL: Difference between order signal and response signal in a servo. Error signal is fed into the servo amplifier.

ESR: Equivalent service rounds. Standard unit of measurement for determining number of rounds fired, to estimate resultant wear of gun.

EXERCISE HEAD: Forward section of torpedo, loaded with inert liquid, expelled at the end of the torpedo's run to make the torpedo float.

EXPLODER: In a torpedo, equivalent to projectile fuze.

EXPLOSION: See DETONATION:

EXPLOSIVE: Any material that can detonate.

EXPLOSIVE D: Ammonium picrate, a nonsensitive explosive.

EXPLOSIVE TRAIN: Group of explosive units designed to function in sequence.

FEEDBACK (SERVO): Servo output signal fed back to input, to regulate servo action.

FIN-STABILIZED ROCKET: Rocket stabilized by aerodynamic surfaces on its tail.

FIRE CONTROL: System controlling the armament of the ship.

FIRING STOP MECHANISM: Device preventing own ship weapons from firing into own ship structure.

FIRING LOCK: Part of gun (a mechanical unit) housing the firing pin (or striker) which contacts (or strikes) the primer.

FIRING PIN: Metal pin that can fire primer by electrical contact and/or by percussion.

FIXED AMMUNITION: Gun ammunition of which each round constitutes a single unit.

FLAREBACK: Ignition of residual vapors in a gun bore after firing. These vapors ignite as they come in contact with air when breech is opened.

FLUID: Substance in liquid state that continuously takes the shape of its container. (The term fluid means the same as liquid.)

FOLLOWUP SYSTEM: See SERVO.

FORCE: Power which causes (or tends to cause) an object to move or, if object is moving, to change its direction or rate of motion.

FOUL BORE: Gun bore containing residual gases after firing. In small arms, a bore contaminated by excessive solid residue.

FREQUENCY: Number of vibrations per time unit (usually per second).

FUZE: Mechanical, electrical, electronic, magnetic, or combination device used to initiate the first element in an explosive train of a projectile at the proper time and under certain circumstances. (A fuze is designed to prevent initiation at other times.)

FUZE SETTER: Device for adjusting time fuzes just before firing.

GFCS: Gun fire control system.

GIMBAL: Metal ring or similar support rotating freely on a pivot.

GMLS: Guided missile launching system.

GUN FIRING: Process of shooting a gun (or guns).

GUNNERY: Operation and control of all armament elements.

GUNNERY DOCTRINE: General instructions on course of actions to be taken by officers supervising weapon operations in specified tactical situations.

GYROSCOPE (GYRO): Device using the rotational inertia of a spinning wheel to establish a reference direction (or plane) in space, or to provide displacement in another direction proportional to any force that tends to twist the axis of the wheel.

HAND CONTROL: On certain electric-hydraulic gun-mount power drives, mechanical-hydraulic servo controlled by mount personnel.

HANDLING ROOM: Compartment aboard ship used for transporting and, to a certain extent, for stowing ammunition.

HANGFIRE: Accidentally delayed ignition of primer, igniter, or propellent charge.

HIGH EXPLOSIVE: Any detonating compound or mixture, such as Explosive D, TNT, RDX, HBX, etc.

HOLDING-DOWN CLIPS: Parts that prevent base ring from being tipped out of the training circle.

HOMING: Final stage of a homing torpedo's run in which it steers itself toward a detected target, also applies to other target seeking devices.

HORIZON CHECK: Comparison of elevation dial readings when battery element is laid successively on a series of points on the horizon.

HORIZONTAL PLANE: Plane tangent to the earth's surface or parallel to such a plane.

HOUSING (GUN): Main support of recoiling gun parts; also houses breech mechanism.

HUNTING: Tendency of servo system output to oscillate due to weak signal, insufficient feedback, excessive gain, or other malfunction.

HYDRAULICS: Study of action of liquids under pressure in enclosed systems. In this course, the study is expanded to include action of liquids at rest in open systems (hydrostatics).

HYDRAULIC SPEED GEAR: Combined A-end and B-end, with associated piping and other components.

IGNITER: Unit in propellent train which sets off the propellant.

ILLUMINATING PROJECTILE: Projectile containing a chemical flare and parachute. (Abbreviation: Illum.)

IMPULSE CHARGE: Propellent charge consisting of black powder, formerly used to eject depth charges and torpedoes from their launching devices.

INDEX OF PROPELLANT: Blend of several lots of propellant powder.

INDICATOR RECEIVER REGULATOR (usually called INDICATOR-REGULATOR or RECEIVER-REGULATOR): Equipment which controls weapon mount power drives.

INDIRECT FIRE: Fire delivered into a target ashore which is not visible from the ship and therefore cannot be used as a point of aim.

INITIAL BALLISTIC CORRECTION: Ballistic corrections which are not automatically compensated for by the fire control system.

INTERMEDIATE CALIBER (GUN): Gun whose caliber exceeds 4 inches, but is smaller than 8 inches.

JAN: Joint Army Navy.

LADDERS: Method of spotting target by opening fire short of target and then increasing range in steps larger than pattern size.

LINER: Cylindrical insert in gun tube. In some guns, insert is engraved with rifling grooves.

LOCAL CONTROL: Control of a gun by means of signals originating in the mount.

LOS: Line of sight.

LOW SPEED SYNCHRO: Synchro rotating at 1 : 1 ratio with input, also called coarse unit.

MACHINE: Mechanical system employing one or more basic mechanisms.

MAGAZINE: Compartments aboard ship designated for ammunition stowage.

MAGAZINE SAMPLES: Propellant samples used for checking smokeless powder for decomposition. These samples are kept in airtight bottles containing chemical indicator paper strips impregnated with 1/10 normal methyl violet.

MAJOR CALIBER (GUN): Gun of 8-inch or larger caliber.

MANUAL CONTROL: Positioning of ordnance equipment without use of power units.

MEAN BATTLE RANGE: Range at which a gun is most effective. At this range gun sights may be boresighted.

MECHANISM, BASIC: Mechanical component, such as a lever, gear, pulley, etc.

MERRY-GO-ROUND: (1) Drum magazine in rocket launcher Mk 108. (2) Rotating cage used for ammunition transfer in certain 5-inch gun mounts.

MFCS: Missile fire control system.

MIL: Unit of angular measure used in naval gunnery to specify sight deflection. One mil is the angle whose tangent is 0.001 (arc tangent 1/1000).

MINOR CALIBER (GUN): Gun whose caliber exceeds 0.60 inch, but is less than 4 inches.

MISFIRE: Failure of primer to ignite when firing action is initiated.

MOUNT (GUN): Structure which supports gun and enables it to be elevated, trained, and fired.

MPI: Mean point of impact, geometrical center of all points of impact in a salvo.

MTF: Mechanical time fuze.

MULTIBASED POWDER: Gun propellant compased of one or more explosive constituents in addition to nitrocellulose.

NAVORD LISTS: Navy Ordnance Allowance Lists.

NEUTRALIZATION SUPPORT FIRE: Support fire intended primarily to hamper or prevent enemy movement of action.

NOMINAL INITIAL VELOCITY: Initial velocity assigned to a new gun with propellant temperature at 90°F.

NONAUTOMATIC (GUN): Gun which does not use the energy of a propellant to perform breech operations or ammunition loading and ejection.

NONFRAG: Non fragmenting projectiles used in AA gun practice which produce colored smoke (but no fragments) when they detonate.

NOSE CAP: Armor-penetrating part of armor-piercing projectile.

NUCLEAR (ATOMIC) WEAPON: Explosive device using nuclear reactions as source of disrupting energy. (In context, the term special weapons means nuclear weapons.)

NULL: In servo terminology, zero implies complete absence of a signal; null implies that there is no perceptible signal, although noise and random nonsignal voltages may be present.

OFFSET CENTERLINE: In drydock battery alinement, a line established ashore, parallel to the drydocked ship's centerline.

OP: Ordnance Pamphlet (technical manual).

ORDALT: Ordnance Alteration, a prescribed change in ordnance equipment.

ORDER SIGNAL: Control signal received from outside the servo.

ORDNANCE: Weapons and their associated equipment. Aboard ship, ordnance includes all elements of ship's armament.

ORDNANCE ALLOWANCE LISTS: Lists of required ordnance materials for naval organizations afloat and ashore.

ORIGIN OF RIFLING: Start of rifling land, just forward of chamber.

OVEN TEST: Method of testing smokeless powder by heating it in an oven.

PARALLAX: The resulting angular difference between observations or computations of one target from two different stations. Horizontal (train) parallax is the angular difference measured in horizontal plane; vertical (elevation) parallax is the angular difference measured in vertical plane.

PARALLAX ERROR (TELESCOPE): Deceiving target displacement when the eye is shifting around the optical axis of the eyepiece of the telescope.

PATTERN OF SALVO: In range, distance measured parallel to the line of fire between the shot falling (or bursting) at the greatest distance from the firing point and the shot falling (or bursting) at the shortest distance (except wild shots). In deflections, distance measured at right angles to the line of fire between the shot falling (or bursting) at the greatest distance to the right, and the shot falling (or bursting) at the greatest distance to the left (except wild shots).

PDF: Point-detonating fuze.

PERCUSSION (FIRE): Firing a primer by mechanical impact.

PHASE: Angular relationship between two alternating currents or voltages. For instance, between a signal voltage and a reference voltage, when the voltage or current is plotted as a function of time. When both voltages are in phase, the angle is zero, and both voltages reach their peaks of value simultaneously; when the voltages are out of phase, one of them leads or lags the other. At the instant when one voltage reaches its peak, the other may not be at its peak and (depending on the phase angle) may differ in polarity as well as in magnitude.

PLASTER LOADED or SAND LOADED AMMUNITION: Similar to service ammunition, except for inert load instead of burster.

PLUG: See BREECHBLOCK.

PLUG GAUGE: Instrument used to check adequacy of clearance in gun bore.

POINT OF AIM: Point on a target to which sight is directed.

POINTER: Person who moves a weapon in elevation.

POWDER FOULING: Propellant residue in gun bore and chamber after firing.

PREDICTING: Process of determining future target positions. Predicting operations are accomplished by using computers during tracking.

PRESENT RANGE: Best available measurement of target range.

PRIMARY EXPLOSIVE: Very sensitive explosive, such as mercury fulminate, DDNP, lead azide, lead styphnate, tetracene.

PRIMER: First unit in a propellent train.

PROGRAMMING: Setting up automatic equipment to perform certain operations in proper sequence.

PROJECTILE: Component of gun ammunition which is expelled from the gun by force of burning propellant.

PROPELLING CHARGE (PROPELLANT): Any mixture or substance that burns rapidly (usually incorporating most of its oxygen), but does not detonate; commonly used to propel rockets, gun projectiles, etc.

PROTOTYPE: Early (usually first) equipment model used as example for mass reproduction.

PYROTECHNICS: Munitions designed to produce light or smoke for illumination and/or signaling.

RANGE TABLE INITIAL VELOCITY: Initial velocity for which the range table is computed.

RANGING: Process of establishing distance of target from firing ship.

RDX: High explosive. Main constituent of compositions A, B, and C. (For detailed description, see appropriate OP.)

RF: Rapid fire. In RF guns, loading, firing, empty-case ejection, and breech operations are performed automatically by means of power received from another source than from the propellant.

RECOIL: Rearward thrust of gun caused by firing of gun, also movement of gun parts in response to this thrust.

RECOIL MECHANISM: Mechanical or hydraulic brake that absorbs a certain amount of recoil energy.

REFERENCE PLANE: Arbitrarily chosen plane, usually within the ship, from which the relative elevation angles of all battery elements are measured. It may be the plane containing one of the battery roller paths, the ship's deck, or an imaginary (nonexistent) plane.

REFERENCE SUPPLY: AC voltage of specified frequency and phase, supplied to energize synchro and servo systems. Reference frequencies are usually 60 cps and 400 cps.

REFERENCE VOLTAGE: Ship's AC supply, used to energize power supplies and servomotor fields.

RELIEF VALVE: Valve that automatically opens to relieve excessive pressure. (A safety valve is also a type of relief valve.)

RESPONSE: In a servo, the movement or signal effected by servo operation. This signal, also called feedback, is fed back into the error sensing device.

RESTRICTED WEAPONS: Atomic, biological, and chemical weapons, also called ABC weapons,

RIFLING: Spiral grooves in the inner surface of the gun bore.

ROLLER PATH COMPENSATOR: Mechanical device which automatically introduces a compensating tilt at all train angles, to correct tilt of roller path.

ROTATING BAND: Raised copper band, near the aft end of the projectile, that imparts rotation to the projectile as it passes through the gun bore.

SALVO: Two or more weapons fired at the same time.

SALVO LATCH: Mechanical interlock designed to prevent accidental opening of gun breech in event of misfire or hangfire.

SEAPOWER: That portion of a nation's overall power which enables it to control the sea in furtherance of its interests, objectives, and policies.

SEMIAUTOMATIC (GUN): Case gun in which some of the propellent energy is used to open the breech, to eject the empty case, and to close the breech when the next round is loaded.

SEMIFIXED AMMUNITION: Two-piece gun ammunition. Each round consists of a primed propelling charge in a metal case and a projectile.

SERVICE AMMUNITION: Complete ammunition assemblies fit for service.

SERVO SYSTEM or SERVO: System in which a relatively powerful driving unit responds to a relatively weak signal. The response is fed back to the sensing device at the input end of the system and is compared with the incoming signal; the operation of the driving unit is controlled in correspondance with the signal. A servomechanism, also called a followup system, is a type of servo system with mechanical components which may be driven by an electrical servo motor.

SERVO MOTOR: Unit of servo system that drives the load, especially the electric drive motor in a servomechanism or in the gun elevation or training gear.

SETBACK: Force of inertia that tends to move fuze parts to the rear when a projectile or rocket is fired. Setback is often used as the first step of arming.

SIGHT: Optical device that establishes line of sight (LOS) to target and provides for positioning of weapon or director with respect to LOS.

SINGLE BASE POWDER: Gun propellant containing only one explosive ingredient, nitrocellulose.

SINGLE SPEED SYNCHRO OPERATION: Use of one synchro system to transmit shaft rotation data at a 1 : 1 ratio with original signal.

SLIDE: Structural support for all gun mount parts that move in elevation.

SLIDE CYLINDER (GUN): Cylindrical after part of barrel.

SLIPRING: Rotating annular contact.

SMALL ARMS (CALIBER): Arms whose caliber is 0.60 inch or smaller.

SOCKET RING: Part of an axial piston pump which can be adjusted to regulate pump output.

SPCG: A multibased smokeless powder which contains nitroglycerine.

SPENT BRASS: Used cartridge cases.

SPOT: Correction to be applied to gun position in order to hit target.

SPOTTING: Estimating required correction in range, elevation, deflection, and fuze range, in order to hit target. (A spotter is a person who observes the fall of shot (or burst) and estimates the required corrections; a spot is the required correction estimated by the spotter.)

SS: Star shell, an illuminating projectile.

STABLE ELEMENT: Gyroscopic device which maintains a horizontal reference plane. (Related device for vertical reference plane is called stable vertical.)

STAND: Foundation of gun or rocket mount. It incorporates training circle and is secured to ship's structure.

STAR GAUGE: Instrument for measuring wear in gun bore.

STAR SHELL: See SS.

SURVEILLANCE TEST: See OVEN TEST.

SYNCHRO: Electro-magnetic device used primarily for transfer of angular position data.

SYNCHRONOUS MOTOR: AC motor designed to operate "in step" with the AC supply; hence, it has a constant-speed characteristic, with its accuracy limited only by the steadiness of supply frequency.

SYSTEM ALINEMENT: Adjustment of two or more major components of a weapon system to insure proper geometrical relationship.

TARGET GRID SYSTEM: Method of using a grid spot converter, to make the spots observed by shore fire control parties available without delay to the ship's fire control systems.

TACHOMETER GENERATOR: Generator whose voltage output is directly and precisely proportional to its rate of rotation. A tachometer generator is frequently used as a damping generator.

TACTICAL MINING: Mining performed in connection with a specific naval operation.

TOMPION: Plug inserted in gun muzzle to protect bore.

TARGET ACQUISITION: Process of positioning the tracking apparatus of a control system so that a designated target is gated in the radar, optical devices, or open sights.

TARGET ANGLE: Relative bearing of own ship from the target, measured horizontally from bow of target, clockwise from 0 to 360 degrees.

TARGET DESIGNATION: Selection of targets to be taken under fire and transmission of information required for acquisition to the selected fire control station (or stations). The target designation types and methods are as follows:

A. Target designation types are classified according to the stations originating the designations:

1. Command designation -- Designation of a target by a command station.

   a. OTC (Officer in Tactical Command) designating vessel to take target under fire.

   b. CO (Commanding Officer) of vessel designating target to be taken under fire.

2. Control designation -- Designation of a target from a fire control station.

3. Local designation -- Designation of a target by personnel of mount or turret.

B. Target designation methods are classified according to designation procedures:

1. Automatic designation -- Designation of target by means of instruments which transmit sufficient data to the selected gunfire control system for target acquisition.

2. Partially automatic designation -- Designation of target by means of a partially automatic system which must be coached, in order to position the selected director to acquire the target.

3. Verbal designation -- Oral designation of target (by voice or telephone).

TARGET EVALUATION: Estimates of target intent, degree of threat, and type of attack to be delivered, based on plots of target position.

TETRYL: Aniline based organic compound, a high explosive.

THROWN WEAPONS: Small contact or proximity fuzed A/S explosive devices thrown by a rocket or mortar from attacking surface vessels.

TIME OF FLIGHT: Time interval from firing of projectile until its impact or explosion.

TNT: Trinitrotoluene, a high explosive.

TRACER: Tyrotechnic device on projectile which shows flight path of projectile.

TRACKING: Process of establishing path of a moving target with respect to firing ship, accomplished by computing the data obtained through aiming and ranging processes.

TRAIN: Movement of weapon in azimuth.

TRAIN ALINEMENT: Alinement of fire control and weapon system elements to make them parallel and at exactly the same angle to a selected vertical plane.

TRAINER: Person who trains a weapon.

TRAINING CIRCLE: Internal gear inside the stand.

TRAINING GEAR: Mechanical, electrical, and hydraulic equipment used for training weapons.

TRAMMING: Procedure for checking train and elevation dial-accuracy of gun mounts.

TRANSMISSION CHECK: In fire control system alinement, process of checking if data-transmission system is functioning with required accuracy.

TILT BOX: Part of axial piston pump containing socket ring.

TRITONAL: Mixture of TNT and aluminum powder.

TRUNNIONS: Part of gun mount slide, center of rotation during elevation.

UFCS: Underwater fire control system.

ULTRASONICS: Sound above range of frequencies audible to normal human ear.

UPPER CARRIAGE: Part of the rotating structure of a gun mount which contains the trunnion bearings.

VT: Proximity fuze.

WARHEAD: Forward section of torpedo or missile laden with explosives.

WEAPON: Destructive unit of a weapon system, except guns, capable of destroying the target (usually by explosion).

WEAPON SYSTEM: Combination of weapon (or weapons) and equipment which project the destructive part of the weapon (or weapons) against the enemy. The functions of a weapon system are as follows:

1. Detects, locates, and identifies the target.
2. Delivers or starts delivery of weapon to target.
3. Controls delivery unit and/or weapon.
4. Destroys the target.

W Q & S BILL: Watch, Quarter, and Station Bill, a chart showing for each billet the name and rating of person assigned, cleaning and maintenance station, and assignments to condition watches and specific bills.

The following discussion will cover a ship's gunnery department organization.

Upon completion of this course, you will be ordered aboard ship. After reporting aboard, you will be assigned to one of the divisions directly associated with ship's armament. Your job will be to assist, under supervision of a petty officer, in the care and maintenance of the armament of your division.

The gunnery department of combat vessels whose main armament consists of guns is headed by the gunnery officer, who, in turn, is responsible to the captain.

The gunnery department consists of several divisions which are designated by special letters or numbers. Each division is headed by an officer responsible to the gunnery officer.

The illustration on the following page shows a typical gunnery department organization of large combat ships (such as cruisers and frigates). The first and second divisions (sometimes also the third division) man the main battery (gun mounts or turrets) or, on guided missile vessels, the guided missile launchers; the third and the fourth divisions man the secondary battery (5-inch dual purpose mounts); the fifth and the sixth divisions man the 3-inch AA mounts.

On guided missile cruisers which also carry gun turrets, the first and the second divisions man the turrets, while the seventh and the eighth divisions man the missile launchers and their weapon control systems.

The F division personnel man the gunfire control equipment and the plotting rooms; on ships which have two fire control divisions, the FA division mans the AA fire control system, and the FM division mans the main battery system.

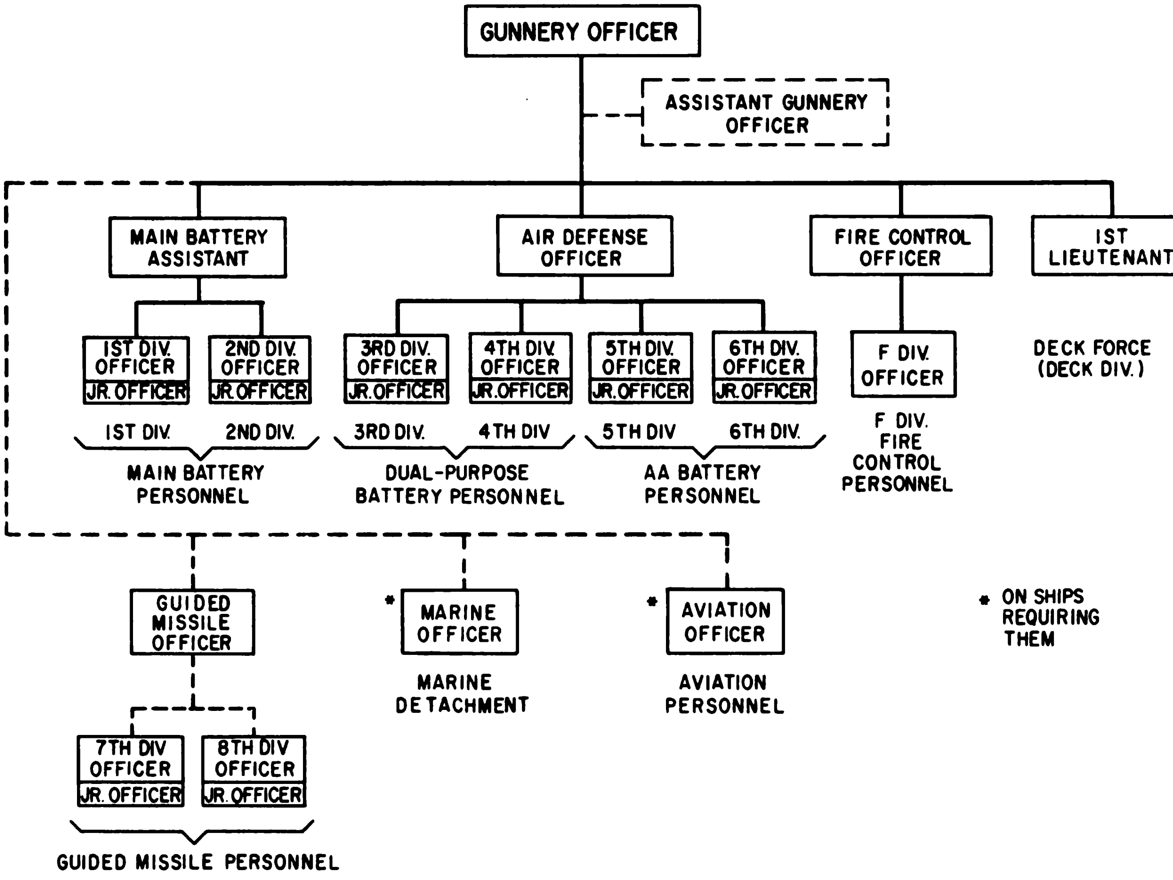
As shown on the diagram, each division has a division officer and usually a junior division officer assistant. Most of the division officers do not report to the gunnery officer directly, but through an additional echelon. The officers of the first and of the second divisions are under command of the main-battery assistant; the officers of the third through sixth divisions are under the command of the air defense officer; the officers of the F division are under command of the fire control officer.

However, the illustration is not to be considered a complete organizational chart: Certain technical personnel (such as warrant gunners) are omitted, and functional relationships are not shown. Also, the assistant gunnery officer may perform double functions (may act as one of the battery or division officers).

On small ships, the gunnery department organization follows the pattern of larger ships. However, since small ships have fewer officers and, relatively, a greater variety of armament than large ships, some of the billets are expanded to cover more functions.

To fully understand your ship's organization, if you have any questions, do not hesitate to ask the petty officers of your division.

> NOTE: All manuals, illustrations, and charts will be useless, unless your gun, mount, or missile launching system is always in top condition; planning, training, and drills will all be just a waste of time, if your guns fail to operate at the right moment. It's up to you to keep them firing.



1. TYPICAL GUNNERY DEPARTMENT ORGANIZATION OF A LARGE COMBAT SHIP (SIMPLIFIED SCHEMATIC)

TOPIC 5: IDENTIFICATION AND CARE OF ORDNANCE EQUIPMENT

You Are Now Going To Learn:

1. The identification and care of ordnance equipment.

Discussion Points For This Topic Are:

1. Importance of identification of ordnance equipment.
2. Nomenclature used for identifying ordnance equipment.
3. Means of identification.
4. Maintenance of ordnance equipment.
5. Ship's Navy yard and tender availability periods.
6. Review and summary.

INFORMATION AND DISCUSSION:

In order to be able to identify ordnance equipment, it is important that every gunner's mate be familiar with the basic principles of naval classification and cataloguing systems.

Classification and cataloguing of ordnance equipment was necessitated in the 20th century by the development of numerous and complex weapons. Since the methods applied by the Navy for identification of ordnance equipment are extremely complex, it would be possible to furnish in this topic a detailed description of the classification and cataloguing systems used. The following text will cover only the fundamentals of these systems, applicable to a gunner's mate's rating.

Nomenclature:

The standard nomenclature for an item of naval ordnance equipment usually consists of a basic title (name), frequently accompanied by a brief description and identifying numbers.

Example:

3-inch 50-caliber rapid fire twin gun mount, Mk 33 Mod 4

"3-inch" specifies the bore diameter (caliber).

"50-caliber" specifies barrel length in terms of caliber. Since this is a 3-inch 50-caliber gun, its length is 3 x 50 = 150 inches.

"rapid fire" indicates that the ammunition is fed into the gun automatically by a power driven loader.

"twin" indicates that the mount assembly incorporates two parallel gun barrels.

"mount" is the basic title (name). A mount includes not only the guns with their training and elevating gear, but also the shield, power drives, power rammer and loader, and sighting equipment.

"Mk 33 Mod 4" is the abbreviation for Mark 33 Modification 4, which specifies a particular design of a certain mount.

In the Navy identification system, the modifiers in the nomenclature of an item are used rather flexibly; thus, for instance, an ordnance technical manual (OP) may refer to the gun mount mentioned previously merely as "3-in. mount Mk 33 Mod 4." Note that the word "gun" is omitted; when not otherwise specified, "mount" always means a gun mount.

The mark number identifies a major item (for instance, a gun mount) or a principal component (for instance, a sight or a power drive) of a particular equipment design.

When the Navy makes a major change in design (or designs) of new equipment of the same type, the basic title of the equipment remains the same, but the mark number is changed. Thus it is clear that, for instance, the Mk 33 Mod 4 twin mount has a different design than the Mk 34 single mount or the Mk 27 twin mount. (The design of the Mk 27 gun differs significantly from the one of Mk 33 in the design of the slide.)

The mod number ("Mod" is an abbreviation of modification, not model) indicates a minor change in design or an alteration. For example, the Mk 33 Mod 4 mount, mentioned previously, differs from the Mk 33 Mod 2 mount mainly by the feature that the Mod 4 has an aluminum shield, while the Mod 2 does not have one.

Mod numbers may also be changed because of improvements made in equipment design or adaptation of the equipment for mounting it in a different place on the ship, or for the operation with a different associated equipment.

The nomenclature of naval guns or mounts always includes their calibers. Special series of mark numbers are used for each caliber; for instance, all 5-inch guns are numbered in the same series regardless of their bore length. Thus, all 5-inch guns (5"/51, 5"/25, 5"/38, and 5"/54) and their mounts are numbered in a single series of mark numbers.

The nomenclature, mark numbers, and mod numbers for each item of ordnance equipment are assigned by the Bureau of Weapons. The nomenclature of major units is listed in the current edition of OP 0. Nomenclatures of separate units or their components which have mark and mod numbers are listed in the applicable OP or the ordnance supply catalog of the particular equipment.

Gun mounts are identified not only by mark and mod numbers, but also by assembly numbers. This identification system is used because gun mounts (especially large ones) are not single units, but actually combinations of smaller units each of which has already its own mark and mod number. For instance, the 5-inch mount Mk 39 Mod 0 may be equipped with an elevation indicator-regulator Mk 54 of any of a number of mods or with a train indicator-regulator Mk 46 of any of several mods; it may also have a shield Mk 54 Mod 0 or Mk 54 Mod 1, etc. Actually, there are 19 types of similar assemblies designated 5-inch mount Mk 39 Mod 0.

To ease identification, each individual unit of equipment which has a mark and mod number also has its own serial number.

In accordance with Navy standards, weapon systems, fire control equipment, and their principal components are usually identified by mark and mod numbers.

Certain Navy ordnance equipment, such as small arms weapons and ammunition procured from the Army, normally retains the Army designation which consists of the letter M (standing for model) followed by a number (corresponding to the Navy mark number). If there are modifications, this number is followed by the letter A (standing for alteration) followed by a number designating the mod. Thus, "carbine, cal. .30 M 3 A 1" means a certain carbine with a 0.3-inch bore which would correspond, in Navy terminology, to the Mk 3 Mod 1.

Aircraft bombs which have been jointly adopted by Air Force and Navy are identified by AN followed either by Army style identification (M_A_) or by Navy mark and mod numbers.

Units, components, and parts of major assemblies are identified by the numbers that appear on the drawings prepared by their manufacturer.

For example, Bureau of Ships drawing number S2407-F-3235506 shows a complete compass-repeater mechanism which is identified as Ship Course Indicator Mk 6 Mod 5A. On this drawing, all parts which constitute the unit are also identified. Furthermore, it is indicated how to assemble the complete unit and of which material the individual parts are made by reference to the specification publication.

> NOTE: A specification is a Government issued publication which lists the requirements that a certain part or material must meet in order to be accepted by Government inspectors

when it is delivered under contract to a Government agency.

The same drawing, mentioned previously, also contains three detailed views of the complete assembly: A plan view of the top, a view of assembly in elevation (partly cut away), and a horizontal cross-section view on which each subassembly and part is labeled.

Since the compass-repeater mechanism is a relatively simple device, the complete unit can be shown on one sheet. More complex assemblies, however, may require several sheets which also are identified by the same number. Separate drawings are required for subassemblies and individual parts. The subassemblies and their parts are then, in turn, identified by their drawing numbers.

Each ship carries technical manuals on maintenance and operation of equipment installed on it. These manuals contain reproductions of engineering drawings which show the equipment described. In addition, ships also maintain files of full size or reduced prints made from original drawings. These files are kept in the gunnery department.

When replacement parts are ordered, the drawing number should be crossindexed and changed to a Federal stock number. The Navy material catalogs issued by various Navy activities, such as the Ordnance Supply Office or Electronics Supply Office, list the stock numbers together with the drawing numbers. When non-Federal stock items are requested, the name, drawing number, and mark and mod numbers of the item and associated equipment, and all other pertinent information should be furnished.

Standard hardware (common nuts, bolts, flat washers, and grommets) and standard electrical units (fixed capacitor, lamps, electronic tubes, and fixed resistors) are identified in Navy material catalogs by standard letter-number combinations.

Each major item which is assigned a mark and mod number (or the equivalent) bears a metal nameplate secured to some easily visible place on its outside. This plate is engraved (or printed) to provide the following information:

1. Standard nomenclature of the equipment, including the mark and mod number (or equivalent) and identification number of the system of which it is a part (unless item is a complete, selfcontained unit).

2. Standard Navy stock number, Federal stock number, or other catalog identification number.

3. Name of cognizant bureau.

4. Manufacturer's part number or drawing number.

5. Name of manufacturer.

6. Number of contract under which item was manufactured.

7. Serial number, assembly number, or other numbers which identify the specific unit. (Items produced in large quantities may have lot numbers instead of assigned serial or other numbers.)

The nameplate may also contain other information, such as voltage and frequency of electric power to be supplied to the unit, safety precautions to be observed while operating the unit, blank space for recording alterations that have been made, etc. Since equipment procured by various Navy activities may be slightly different, the nameplate is always the best primary source of identification.

Nameplates should never be detached, obliterated, or permitted to become illegible, either through accumulation of grime and dirt, or by being painted over, or by overscouring which would erase the information. The information contained on the nameplate should never be changed or additional data added, except when specifically directed to do so by the cognizant bureau.

Many small assemblies and parts are identified by special numbers or coded markings. The numbers may be Navy catalog numbers or contractor drawings numbers; the code markings may consists of symbols used on the schematics. To facilitate identification of individual parts, it is therefore important to have the technical manual or instruction book for the particular equipment, and, if possible, the appropriate part of the Navy material catalog and the available prints or drawings.

The information needed for identification of ordnance equipment depends upon the specific purpose. For example, for identifying the entire equipment as a functional unit, the name, mark number, and mod number are sufficient; but for requesting spare parts from the Bureau of Ordnance, the serial number (and the assembly number, if any) may also be necessary. (This combined information enables the factory or depot to identify the equipment by using its manufacturing records.)

Maintenance:

Aboard ship, maintenance work consists mainly of upkeep which includes preventive maintenance, repairs, and alterations.

Most of the modern ordnance equipment is extremely complex and requires frequent periodic checks, exercising, tests, painting, corrosion proofing, lubrication, and adjustments to keep it in proper operating condition. This daily and weekly work is called preventive maintenance, because it is performed in order to discover and to eliminate possible sources of trouble, to prevent a actual trouble from occuring. Check-off lists containing detailed descriptions of the work to be performed daily, weekly, monthly, etc., are issued by type commanders.

With each ordnance installation, the Bureau of Weapons furnishes publications which outline the maintenance procedures. (These publications will be discussed in the following topic.)

In Navy Regulations, repair is defined as follows: Work necessary to restore a ship or an article to serviceable condition without change in design, materials, number, location, or relationship of the component parts.

Repairs include troubleshooting and replacing or restoring of equipment or parts to serviceable condition. Operational failu of equipment may be caused by wear, rust, or corrosion, by malfunction of some other part of equipment, by personnel error, or enemy action.

Repairs may be performed by the following three activities:

1. Ship's force.
2. Repair ships (tenders).
3. Naval shipyards.

Repairs, as mentioned previously, do no include changes made to improve equipment Such changes are called alterations.

According to Navy-Regulations, an alter tion is any change in the hull, machinery, equipment, or fittings which involves a change in design, materials, number, location, or relationship of the component parts of an assembly regardless of whether it is undertaken separately from, or incidental t or in conjunction with, repairs.

No alteration may be performed on any ship or article on board without authorizatio from the bureau concerned. Alterations to modify ordnance equipment which change th characteristics of a ship may be authorized only by the Chief of Naval Operations and a issued by the Bureau of Weapons. These authorized alterations are serially numbere as NavAlts.

Authorized alterations to ordnance equip ment which do not change the characteristic of a ship are issued by the Bureau of Weapons and are serially numbered as OrdAlts.

Both NavAlts and OrdAlts contain comple descriptions of the changes to be incorporated, information about the purpose and priority of the alterations, name of agency which will perform the work, procurement material (if any), and all necessary plans, diagrams, and specifications.

Repairs and alterations are sometimes interwoven: Certain repair operations involve more than just restoration of equipment to operating conditions without changi its original design. For example, a defective part may be replaced by a part of different material or of more efficient design, or certain parts may be strengthened, or minor changes may be made to prevent recurrence of certain casualties or to prevent damage to the ship's structure. These operations are called alterations equivalent to repair. However, alterations equivalent to repair should never increase the original weight of the unit.

The ordnance machinery history is one of the most important records of the gunnery department. The gunnery officer is responsible for keeping these records complete and up-to-date. The records are kept on standard looseleaf form cards in a hard binder. The entries must include the following information:

1. Major repairs performed.
2. Parts replaced.
3. Material failures.
4. Modifications (OrdAlts).
5. Number and type of rounds fired.
6. Bore erosion and star gauge data.
7. Nameplate data.

A battery log (record book) is kept on each 3" rapid-fire mount and larger mounts. (3" semiautomatic single guns and smaller guns require only one log book for each battery.) It is the responsibility of the leading gunner's mate assigned to the equipment that the daily entries in the logs are made. The entries must include the number and type of rounds fired, casualties, repairs, tests, alterations, and special (not routine) maintenance performed. The logs must also include all mark, mod, and serial numbers of the equipment.

Most of the maintenance work aboard ship is accomplished by the ship's force (naval personnel). Gunner's mates are usually proud of the amount of work the ship's force can perform without formal aid from tenders or shipyards; the more maintenance work the ship's force can do, the better the condition of ship and equipment will be, and the better the crew will get to know the ship and equipment.

However, the extent of repairs that can be performed on a small ship is limited by lack of proper facilities and skilled personnel. A repair ship has more elaborate repair facilities; the personnel are experienced in repair work and are capable of performing most of the major repairs.

Naval shipyards, of course, are capable of handling all major repairs; therefore, every ship is regularly assigned a tender availability or yard availability period, which means that the vessel can tie up to a tender or go into a yard for a specified period and have the work done that is beyond the capacity of the ship force or cannot be performed while the ship is in operation. Such work generally includes major repairs, overhaul of hull, superstructure, machinery, or armament for which the ship's force has neither tools nor skill. In gunnery department installations, an example of such work can be the replacement of a main-battery director or lifting out of a 5"/38 twin mount to substitute parts of its training circle or roller path.

Every important repair or alteration job must be performed during the availability period. Shipyards and tenders are always busy and have plenty of work to do; once the ship's availability period is over, she cannot come back a day or two days latter because some job was not completed or was overlooked.

During the ship's availability periods, the department head and leading gunner's mate keep track of all maintenance work to be performed on the ship's ordnance equipment.

TOPIC 6: DOCUMENTATION

You Are Now Going To Learn:

1. The types and uses of naval publications.
2. Classification and safeguarding of naval publications.

Discussion Points For This Topic Are:

1. Sources of publications.
2. Types of publications:
    a. Technical.
    b. Training.
3. Classification of publications.
4. Handling, stowage, and disposal of classified publications.
5. Review and summary.

INFORMATION AND DISCUSSION:

It is a well known fact that education does not end when you finish school; continual education is important to your naval career as well as to other aspects of your life. When you are aboard ship, you must continue your professional education on your own time either by personal study or by taking correspondence courses.

The information provided in this Trainee's Guide by no means extends to the limits of what you are supposed to know. The competence of a gunner's mate depends not only on his knowledge, but also on his ability to quickly find a reliable source for other necessary information; therefore, a gunner's mate should be familiar with various publications issued by the Navy. Most of them come in series (or groups) and are identified either by serial or code numbers. A common problem is the identification and procurement of publications that are not immediately available aboard ship or at the station.

The main types of Navy publications which a gunner's mate must use aboard ship in connection with ordnance and gunnery equipment are technical and training publications.

Technical Publications

Most of the technical publications are issued by the Bureau of Weapons (BUWEPS) and will be discussed in the following text.

Ordnance Pamphlets (OP's):

Ordnance Pamphlets are technical manuals. There are two types of OP's. Most of the OP's are of that type which describes a specific ordnance equipment, its operation, maintenance, installation, and repair. The other type of OP's describes an ordnance subject in general (for instance, battery alinement or ammunition).

All OP's (unclassified and confidential), as well as many other BUWEPS technical publications, are indexed in OP 0. (Ordnance technical publications with a higher security classification are indexed in RPS 6.)

OP's are numbered consecutively, without coding.

Ordnance Data (OD):

OD's contain a wide variety of technical information, including test and inspection instructions, advanced information on or advanced instructions for ordnance equipment, lists of ordnance equipment for specific types of ships, etc. OD's are numbered serially and are indexed in OP 0.

Ordnance Alterations (OrdAlts):

Ordnance Alterations contain authorized changes applicable to ordnance equipment which do not modify the military characteristics of a ship. (Alterations of ordnance equipment that modify the military characteristics of a ship are authorized by the Chief of Naval Operations and issued by BUWEPS as NavAlts.)

Alterations of ordnance equipment can be authorized only by OrdAlts. The alterations must adhere strictly to the drawings and instructions provided by the OrdAlts. When the changes are completed, they must be recorded in the maintenance records of the gunnery department and must be reported to BUWEPS. OrdAlts are listed in a special index, OrdAlt 00.

Ordnance Instructions and Ordnance Notices:

Ordnance Instructions and Ordnance Notices are BUWEPS issued directives and informational copies. They are numbered according to a decimal system established by the Executive Office of the Secretary of the Navy. The issues are numbered in a special way according to their classification by subjects (for instance, administration, supply, procurement, production, fiscal matters, etc.). All issues are indexed in NAVORD Note 5215.

Ordnance Allowance Lists (NavOrd Lists):

Ordnance Allowance Lists are looseleaf lists of required equipment, ammunition, tools, accessories, etc., for ordnance installations afloat or ashore. Revisions and amendments to these lists are made by issuance of new pages to be substituted for the old ones.

NAVORD Lists are indexed in NAVSANDA Publication 2002, Section XI. This publication supersedes NAVORD Lists 0 and 00.

> NOTE: Ordnance Allowance Lists (NavOrd Lists) should not be confused with Ordnance Equipment Lists which are issued as OD's. Ordnance Equipment Lists are designed for certain classes or groups of ships and are mainly intended to serve as guides for shipyards and shipbuilders.

Coordinated Shipboard Allowance List (COSAL):

COSAL is a single allowance list for each ship with all material (ordnance, electronics, etc.) listed in the same manner. Ordnance material is listed in Chapter 4 which is assembled in a separate binder. In time COSAL may replace NAVORD Lists.

Bulletin of Ordnance Information:

The Bulletin of Ordnance Information is a classified quarterly publication which contains articles about new developments in naval ordnance, equipment under developme or in the fleet, new modifications to ordnanc equipment, new safety information, and other current data. It also lists all publica- tions issued after printing of the latest OP 0

NAVSHIPS Technical Manuals and Instructio Books:

Personnel of the gunnery department use and maintain a considerable amount of equipment which is under the cognizance of BUSHIPS, such as dredger hoists and missi checkout and handling devices. The technic manuals and instruction books describing this equipment are listed as NAVSHIPS publications and are only indexed in and ordere from NAVSANDA Publication 2002, Section VI, Parts D and E. For example: The technical manual on the electrohydraulic equipment for the CLG missile (Terrier) handling system is NAVSHIPS 378-0258. The second and third numbers (78) indicate which section of BUSHIPS Technical Manual (NAVSHIPS 250-000) is applicable to the equipment. Chapter 78, NAVSHIPS 250-000 is titled Ammunition Handling and Stowage.

NAVSANDA 2002, Navy Stock List of Forms Publications:

NAVSANDA 2002 is published by the Bureau of Supply and Accounts. It indexes and provides stock numbers of forms and publications for each bureau of the Navy.

BUWEPS forms and publications are listed in Section VIII.

Graphic laminated placards of operating instructions and safety precautions for ordnance equipment are also listed in NAVSANDA and can be found in Section XIII.

Training Publications

The Bureau of Naval Personnel (BUPERS is basically responsible for all Navy trainin except for aviation, medical, dental, joint team and group combat training, and training in certain fleet schools.

The text materials, designed specifically for training Navy personnel and intended for navywide distribution, are issued by BUPERS. The materials published by BUPERS are used for the following purposes:

1. Navy training courses (Bluebooks) for enlisted personnel intended for their preparation for advancement to specific ratings and grades. (Some of these courses include common subjects like electricity, mathematics, etc.)

2. Navy courses for officers which cover subjects of interest to officers (naval ordnance, gunnery, electronics for guided missiles, etc.).

3. Correspondence courses on specific subjects for enlisted personnel and officers. These courses are based, respectively, on the texts mentioned in Points 1. and 2. Officer correspondence courses are also available to enlisted personnel on active duty, and the successful completion of these courses is recorded in their Service Record. Correspondence courses are administered by the U. S. Naval Correspondence Course Center, Scotia, New York, and are indexed in NAVPERS 10052.

4. Instructor's Guides and Trainee's Guides for use in schools controlled by the Bureau of Naval Personnel.

BUPERS also issues special-purpose publications, one of which is the periodically issued List of Training Manuals and Correspondence Courses, NAVPERS 10061 (number is followed by a letter indicating the revision). This publication serves as a catalog of NAVPERS publications. (All NAVPERS publications are identified by five-digit numbers.)

Classified Publications

Ordnance publications may be classified as TOP SECRET, SECRET, CONFIDENTIAL, or may be unclassified. Ordnance publications are classified by BUWEPS. The Chief of Naval Operations is charged with the responsibility of classification of all material according to its content.

For security reasons, all classified publications are assigned registration numbers. It is required that classified publications be accounted for, including receipt and ultimate disposition.

Everyone is responsible for maintaining the inviolability of classified matter. Classified material is to be handled and stored in accordance with the current edition of the Navy Security Manual for Classified Information, OPNAV Instruction 5510. 1.

Confidential publications must be stored in a fireproof safe locked with a triple combination lock. One man is designated (by official letter) as publication custodian and is made responsible for the publications within the safe. When a classified publication is issued to someone, the person receiving the publication must sign a custody card which is kept by the publication custodian.

Publications classified CONFIDENTIAL (Modified Handling Authorized) may be used in classrooms. When not in use, they may be kept in a cabinet in a locked room, provided that a sentry on watch is in the building at all times.

When an order is given to destroy TOP SECRET, SECRET, or CONFIDENTIAL material, it must be burned, shredded, or pulped. The directing authority normally requires that a certificate of destruction be signed and returned to the directing authority.

TOPIC 7: GENERAL SAFETY PRECAUTIONS

You Are Now Going To Learn:

1. The purpose of safety precautions.

Discussion Points For This Topic Are:

1. Requirement for prevention of accidents.
2. Necessity of safety precautions.
3. Results of carelessness.
4. Review and summary.
5. Section review.
6. Written test.

ASSIGNMENT:

A. Reference publications:

   1. Safety Notice, pages XX through XXII in NAVPERS 93020.
   2. Optional reading list:
      a. OP 3347.
      b. OP 1014.

INFORMATION AND DISCUSSION:

Safety is everybody's job. Awareness of danger, knowledge of how to avoid it, and constant vigilance are the three basic requirements for the prevention of accidents while you are working on or near weapon equipment.

There is more truth than fiction in the adage "Safety precautions are written in blood." It is a fact that safety precautions are mainly derived from costly experiences: Some of the most serious casualties in naval history are attributed to neglect or violation of safety rules in effect or to carelessness and lack of common sense to take precautions which at that time had not yet been written. It is also an established fact that familiarity breeds carelessness.

Safety is both a result and a reflection of good training. The crews of guns or missile launching systems may be trained so that every man thoroughly knows how to do his job; however, the crew still cannot be considered well trained unless every man is safety conscious. Safe working habits must be impressed upon every crewman through proper instructions, constant drills, and continuous supervision.

Carelessness, cockiness, and lack of training have led to disaster while working with all types of ordnance equipment and material. Turrets have exploded; mounts have fired into other mounts of the same ship; ammunition ships were blown up; rockets have burned men to death.

The list of casualties is long. For instance, on October 1, 1951, a 5-inch, 38-caliber gun aboard a destroyer fired into another mount. As a result, six men were killed and fifteen were injured. In the following investigation, the commanding officer and gunnery officer stated that they were unaware that such an accident could be possible: If they had known that one gun could fire into the barrel of another gun, they would have (in compliance with general safety rules) issued additional precautions to prevent such accidents. However, no warning or precautions concerning this hazard had been posted.

The mount captain had not adequately followed the safety requirements: He did not use his sightport to observe the line of fire, to make sure that it was safe to fire. The gun of the mount that was hit (mount 2) was trained and elevated to the READY position, and its barrel was in the line of fire of the firing mount (mount 1). Mount 2 was not firing and was not to fire until after mount 1 had completed its firing. To insure safe operation, mount 2 should have been held ready at its normally secured position, at zero degrees of train. If this had been done, the accident would not have occurred.

There is a cutout cam installed to prevent guns from firing into fixed objects of own ship structure which include turrets, mounts, launcher, torpedo tubes, and cranes (in their stowed positions only). The personnel must constantly watch out that these objects do not interfere with the line of fire. In the incident mentioned before, one of the several persons in charge - the commanding officer, the gunnery officer, the control officer, the mount captain, or one of the safety observers - could have prevented the accident, since no mechanical defects exists; the failure was due to human carelessness only. The result:

DEAD: 6

INJURED: 15

Another example: In May 1949, aboard a destroyer a gunner's mate was cleaning and chipping paint off a 40 millimeter gun mount. For some reason, against all existing orders, he removed the cover plate from the train motor control switchbox (perhaps he intended to clean it). Minutes later he was found dead on the deck: He had been electrocuted by a 440 volt circuit. This accident would not have occurred if the gunner's mate had observed the following safety rules:

> When work is done on any circuit, the switch controlling that circuit should be opened and a danger sign secured to it.
>
> The danger sign should contain sufficient instructions to prevent anyone but the proper individual from energizing the circuit.
>
> Each piece of ordnance equipment has a specific list of safety precautions to be observed during operation and/or maintenance. Study these thoroughly before attempting to operate or repair any piece of equipment with which you are not familiar . . .

Normally, safety rules are considered by all hands as the primary laws of selfpreservation, and therefore willful violations are not common; it is usually the ignorance of their existance and application or a lack of observation, due to overconfidence, that cause the violations.

It is an unquestionable fact that casualties can be prevented by a thorough knowledge and sensible observance of safety precautions. Constant vigilance must be exercised to insure that every detail of the safety rules is followed. Any violations or tendencies to veer from the prescribed course of safe actions must be stopped at once.

Since no human being is perfect, accidents cannot be outlawed or ordered out of existence; however, a large percentage of casualties can be eliminated by proper overhaul of equipment, inspection and test of material, and by adequate training of personnel in proper handling of their equipment. (A detailed list of safety precautions is provided in the required reading list for this topic.)

QUIZ SHEETS:

11. Which one of the following ordnance items is not classified as explosive ordnance?

    a. Torpedoes.
    b. Missiles.
    c. Guns.
    d. Mines.

12. All ordnance publications are classified by BUPERS as Top Secret, Secret, Confidential, and Unclassified.

    True__________or False_________.

13. Technical manuals for ordnance equipment under cognizance of BUSHIPS are issued by

    a. BUWEPS.
    b. BUSHIPS.
    c. BUPERS.
    d. CNO.

14. Guns whose caliber is 6-inches or larger are called major caliber guns.

    True__________or False_________.

15. The gun mechanism that closes the powder chamber of a gun is called

    a. Tompion.
    b. Muzzle disk.
    c. Breechblock.
    d. Salvo latch.

16. Blank gun ammunition may include a primer, propellant, and projectile.

    True__________or False_________.

17. The shattering effect of high explosives is called

    a. Blasting.
    b. Brisance.
    c. Combustion.
    d. Demolition.

18. Which device is used to lock the breechblock in closed position to prevent accidental opening of the breech when a misfire or hangfire occurs?

    a. Safety latch.
    b. Gear latch.
    c. Lock latch.
    d. Salvo latch.

19. Ordnance technical publications with a high security classification are indexed in one of the following publications:

    a. RPS6.
    b. OP 0.
    c. NAVORD List 0.
    d. Ord Alt 00.

20. Training manuals and correspondence courses, issued by BUPERS, are listed in NAVPERS 10061.

    True__________or False_________.

21. List the three basic requirements for prevention of accidents:

    a.______________________________
    ____
    b.______________________________
    ____
    c.______________________________

22. Ballistics is the science of projectiles in motion.

    True__________or False_________.

23. Safety precautions are based mainly on costly experiences.

    True__________or False_________.

24. The F Division personnel man the

    a. Launcher.
    b. Guns.
    c. Magazines.
    d. Plotting rooms.

25. The title of any naval gun always includes its

    a. Mark number.
    b. Mod number.
    c. Caliber.
    d. Assembly number.

26. When new equipment is installed aboard ship, its nameplate should be removed and stowed in a safe place.

    True________or False______.

27. List the three main kinds of shipboard maintenance work:

    a.________________________________
    b.________________________________
    c.________________________________

28. A battery log is kept for each 40 MM mount.

    True________or False______.

29. Authorized alterations to modify the military characteristics of a ship are called

    a. NavAlts.
    b. ShipAlts.
    c. OrdAlts.
    d. MajorAlts.

30. The leading gunner's mate is responsible for keeping the machinery history records up-to-date.

    True________or False________.

31. Replacement parts are ordered by using Federal stock numbers.

    True________or False________.

Accuracy of notes checked by instructor:

Date________________________________

Trainee's initials______________________

Section 2

MATHEMATICS REVIEW

ASSIGNMENTS

Topic No.	Topic Title	Page
1.	Arithmetic	40

TOPIC 1: ARITHMETIC

You Are Now Going To Learn:

Refer to appropriate section of NAVPERS 92662, Section I, Topic 2.

You Will Acquire Skill In:

Refer to appropriate section of NAVPERS 92662, Section 1, Topic 2.

Discussion Points For This Section Are:

1. Arithmetic.

ASSIGNMENT:

A. Reference publication:

    1. Study NAVPERS 92662, Vol. 1, Section 1, Topic 2.

INFORMATION AND DISCUSSION:

The discussion points for Section 2, Topic 1, are thoroughly covered in the assignments. Study the text carefully and in proper sequence.

Section 3

INTERPRETATION OF SCHEMATICS

ASSIGNMENT—DISCUSSION—PRACTICAL WORK—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Introduction to Blueprints	42
2.	Drawing Symbols	46
3.	Drawing Views	52
4.	Notes, Specifications, and Dimensioning	58
5.	Ordnance Drawings	64

TOPIC 1: INTRODUCTION TO BLUEPRINTS

You Are Now Going To Learn:

1. The definitions, types, and uses of blueprints.

Discussion Points For This Topic Are:

1. Definition of blueprints.
2. How prints are made.
3. Types of prints and their uses.
4. Technical sketches.
5. Handling and care of prints.
6. Review and summary.

ASSIGNMENT:

A. Reference publication:

1. Study NAVPERS 10077B, Chapter 1.

INFORMATION AND DISCUSSION:

Blueprints are exact copies of mechanical or other types of drawings. The process for making blueprints is similar to the photographic process for making prints from negatives.

The negative for a blueprint is called a tracing. The tracing is made by placing a sheet of translucent (tracing) paper or cloth over an original drawing. Every detail of the drawing is then copied on the tracing paper or cloth with waterproof black (India) ink or a special black pencil.

A new process of reproducing original drawings is called phototracing. This process is faster and requires less skilled draftsmen than handtracing, but reproduction costs are higher than in the old process.

In the phototracing process, the pencil drawing is considered to be the master (original) until a phototracing has been made; thereafter the phototracing becomes the master. All additional phototracings of the same master can be reproduced in various sizes. Several reproduction processes can be used.

The following is a list of prints which are all reproductions of originals, but are separately classified, because they are reproduced by various processes.

1. Blueprints are the oldest and most common-type prints. They have a blue background with white lettering. Blueprints are valuable long-lasting records and, with proper handling, can be used again and again. Blueprints should be protected as much as possible against the sun because they tend to fade when they are exposed to direct sunlight.

2. Vandykes have a brown background with white lettering. Vandykes differ from blueprints in that they can be used as negatives for duplication. Since the paper of vandykes is thin, they are not as durable as blueprints.

3. Black and white prints have a white background with dark lettering. They are easier to read than blueprints and for this reason are better than blueprints when used as training aids.

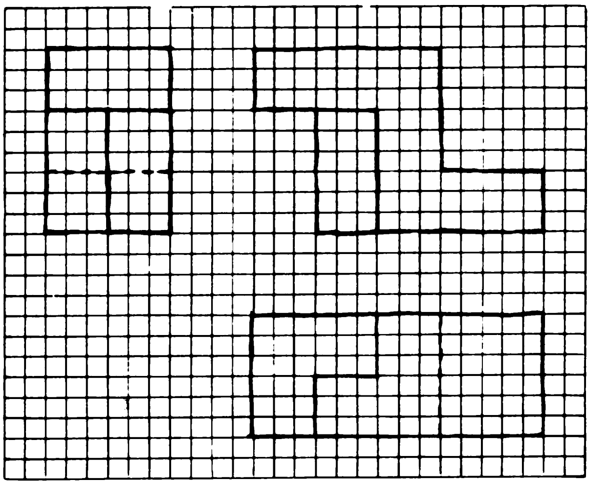
4. Ozalid prints are similar to black and white prints, except that due to the ozalid reproduction process they are not long-lasting.

5. Photoprints are normally 14 x 17 inch prints with white lettering on blue background. Photoprints are standard record prints of drawings furnished to all ships. Photoprints can be obtained on special order with black lettering and white background.

Technical or Working Sketches

Technical or working sketches are often used to show complete assemblies or their separate parts. These sketches can also be made freehand, as shown in the illustration on the adjacent page.

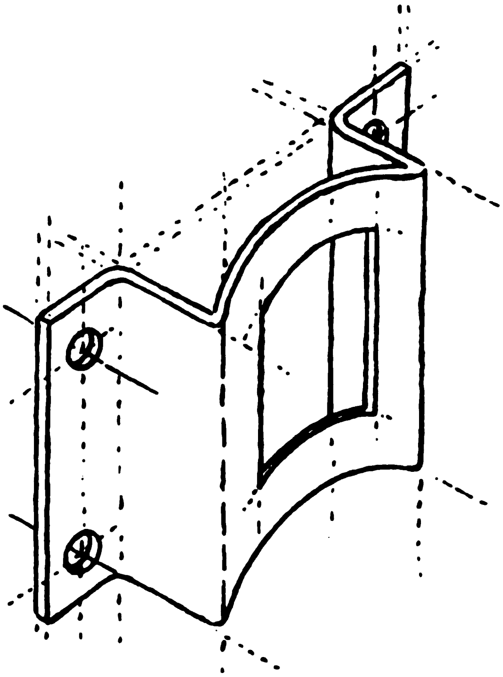
A gunner's mate must be skilled not only in interpreting technical sketches, but also in making them, since many job orders sent



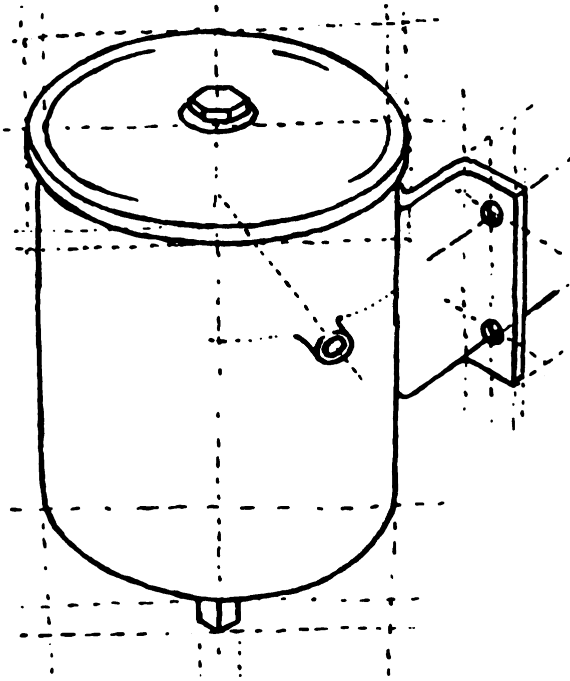
2. WORKING SKETCH ON CROSS-SECTION PAPER

to tenders and Navy yards must be accompanied by sketches of certain items.

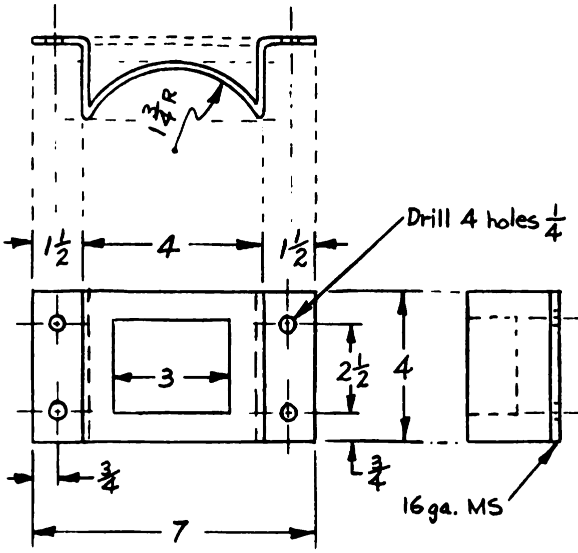
The technical or working sketches should contain the information required for serving the specific purpose; however, the dimensions and notes that appear on the sketches should conform with standards.



3. PERSPECTIVE DETAIL SKETCH OF OIL FILTER BRACKET



4. PERSPECTIVE ASSEMBLY SKETCH OF AN OIL FILTER



5. ORTHOGRAPHIC DETAIL SKETCH OF OIL FILTER BRACKET

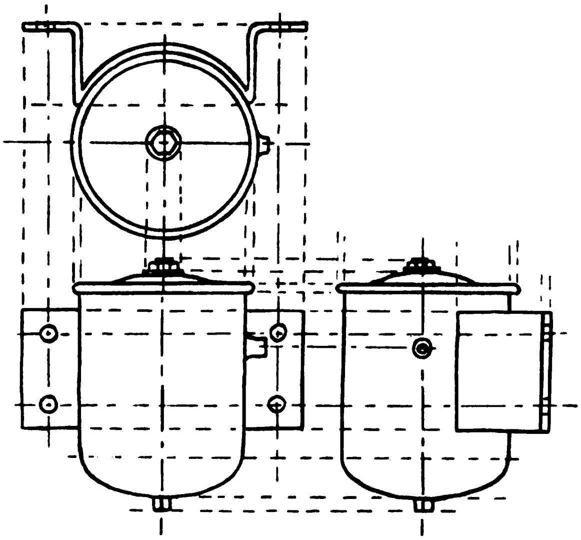
There are four types of sketches:

1. Perspective detail.
2. Perspective assembly.
3. Orthographic detail.
4. Orthographic assembly.

Handling and Care of Prints:

All prints should be filed numerically and stowed for ready reference. However, security regulations require that classified prints be filed separately in locked cabinets.

All prints should be kept free from oil and grease. Prints should be neatly folded in such a way that the title block be visible. Large prints should always be folded in an accordion-like manner. This kind of folding is made by starting at the title block end and by alternately folding the print back to back and face to face.



6. ORTHOGRAPHIC ASSEMBLY SKETCH OF AN OIL FILTER

TOPIC 2: DRAWING SYMBOLS

You Are Now Going To Learn:

1. Types and purpose of drafting symbols.

Discussion Points For This Topic Are:

1. Identification and use of material symbols.
2. Introduction to special symbols.
3. Types and uses of line symbols.
4. Types and uses of thread symbols.
5. Classification and definitions of threads.
6. Review and summary.

ASSIGNMENT:

A. Reference publication:

   1. Study NAVPERS 10077B, pages 17 through 19 and 91 through 101.

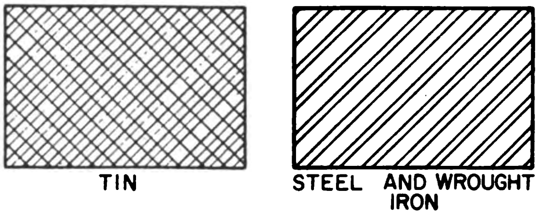
INFORMATION AND DISCUSSION:

In the preparation of drawings, standard drafting symbols are used. Some of these symbols will be discussed in this topic; the symbols used in hydraulic and electrical drawings will be discussed in Sections 7 and 10, respectively.

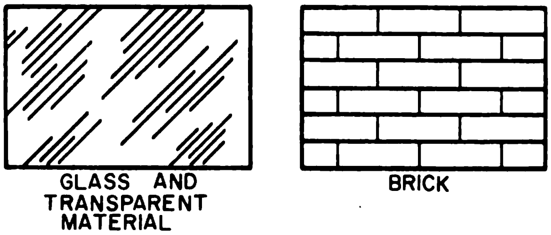
Military standards include symbols of various various materials and thus define the texture of materials. The following illustration shows several types of drafting conventions of various materials.

These material symbols, however, do not include specific classifications of materials; for example, wrought iron, stainless steel, and tungsten steel would all be shown by the same symbol. The specific type of material used is specified elsewhere on the blueprint.

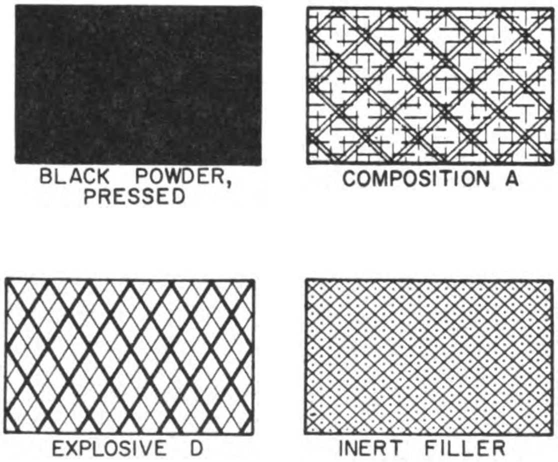
On nonstandard prints, special symbols or or colors may be used. These symbols or colors are always explained in the legend of the print.



SECTIONING CONVENTIONS



EXTERIOR CONVENTIONS

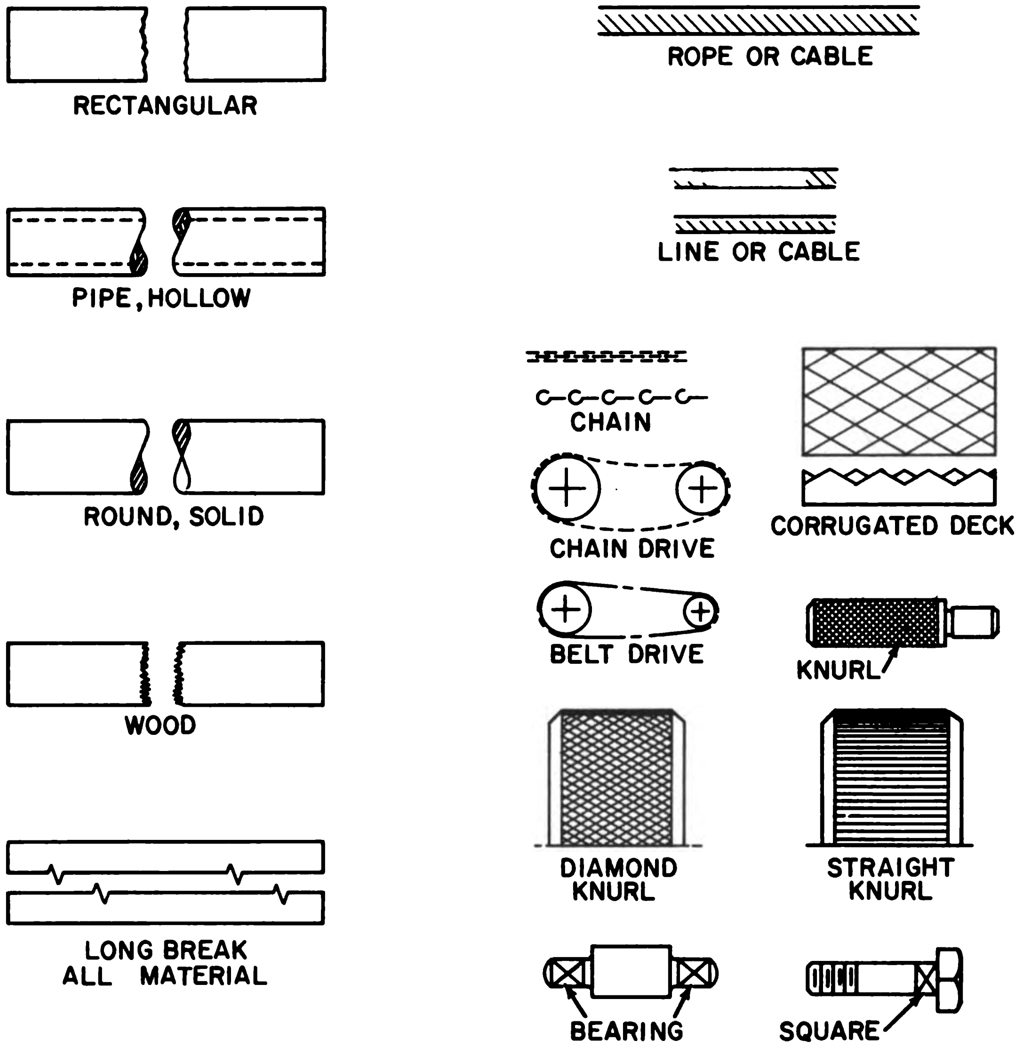


SPECIAL CONVENTIONS

7. DRAFTING CONVENTIONS

The illustration on the adjacent page shows some typical examples of special drafting symbols.

When preparing drawings, a draftsman frequently must present a great deal of information within a limited space. Instead of using words or lengthy written explanations,



8. CONVENTIONAL BREAKS AND SPECIAL SYMBOLS

he uses standardized lines which have various widths and other special characteristics. All these types of lines have their special meanings. To interpret and to understand a drawing or a blueprint, you must know what the various lines mean.

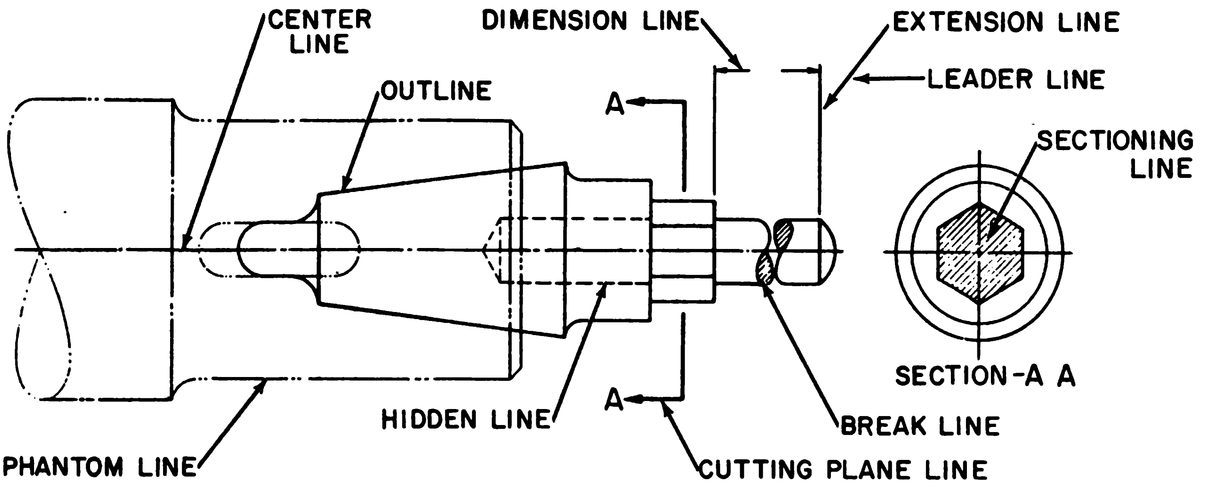
An outline is a heavy solid line, as shown below, which represents the edges and surfaces visible from the point from which the object is drawn.

9. OUTLINE

A hidden line is a light line, as shown below, which consists of dashes and represents an edge or a surface which cannot be seen from the point from which the object is drawn.

10. HIDDEN LINE

The outlines and hidden lines constitute the backbone of a drawing.

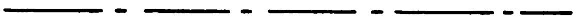


11. VARIOUS TYPES OF LINES

NOTE: For a combination of the various types of lines used, refer to the above illustration.

A phantom line consists of light long and short dashes which alternate according to an established pattern: one long dash and two short dashes. Phantom lines are used to indicate hidden parts and the alternate positions of moving parts. (Refer to illustration above.)

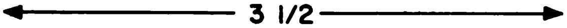
A centerline consists of light alternating long and short dashes, as illustrated below. Centerlines are used to indicate the center of a circle or an arc and to show the division into equal parts of the object on the drawing.



12. CENTERLINE

Dimension lines are used to indicate the size of the object shown on the drawing. Generally, Navy blueprints are dimensioned in inches.

The preferred way of indicating dimensions is shown in the illustration in the adjacent column. The measurement given show shows the distance between the points of the arrowheads. Other ways of indicating dimensions are shown in the illustration on page 62.



13. DIMENSION LINE

It is preferred that dimensions be placed outside the view of the object, because dimensions placed inside the outline of the drawing interfere with the view of the object.

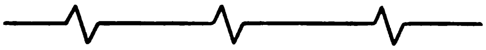
Extension lines are light lines which extend from the lines of the outline of the object. (Refer to the illustration shown above.) Extension lines are used for placing the dimension lines outside the view of the object. They usually start about one-sixteenth of an inch from the outline of the object.

Refer to the illustration shown above and note how the various lines are labelled. Each line designation is tied to the corresponding line of the drawing by a leader. For exact indication of dimensions and dimensional or other explanatory notes, only leaders consisting of straight ruled lines should be used. The note end of the leader should always point either to the beginning or to the end of the dimension or note (never to the middle). In general, dimensional leaders should point only to that part of the drawing which shows the profile (outline) of the object.

Drawings usually have a better appearance when the adjacent leaders are parallel; however, leaders should never be parallel to adjacent dimension lines or extension lines.

On drawings which contain symmetrical features, the leaders should point to the center of the feature. The arrowhead of a leader should end exactly on the line which represents the profile of the object.

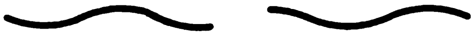
Since most drawings are limited to a certain size, the draftsman must frequently reduce large objects which would take up more space than permitted. However, to avoid undersizing, a draftsman may use long break lines, as shown in the following illustration, to indicate that he has shortened a part on the drawing.



14. LONG BREAK LINE

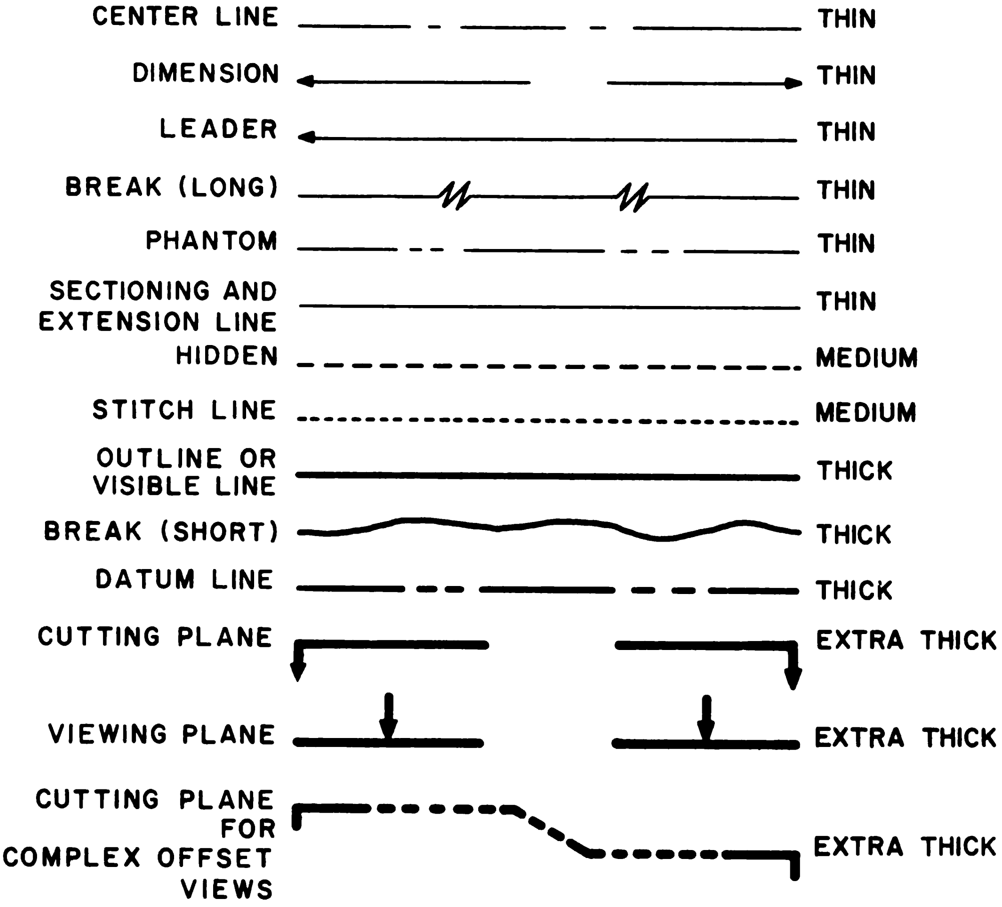
NOTE: The long break line, which is used only as a space saver, does not change the actual dimensions of the object.

Short break lines are used to indicate that the draftsman has intentionally omitted a part of an outer surface in order to show the inside of the structure. Short break lines are generally used in pairs, as shown below.



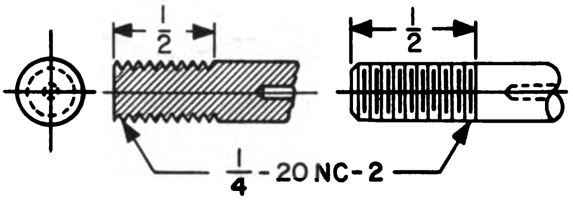
15. SHORT BREAK LINE

NOTE: The various types of lines used on drawings are shown on the following illustration. Carefully study the designations of these lines and learn to distinguish them by their widths and other characteristics.



16. LINE CHARACTERISTICS AND CONVENTIONS

On ordnance drawings, threads may be represented in various ways. Refer to illustration below and note that on the right part of the drawing, a common method of showing threads is used. The left part of the drawing presents the end view of a threaded shaft or bolt. The center part of the drawing presents the profile and sectional view of a thread.



17. OUTSIDE THREADS

To save time, the draftsman used the standard symbol for representing a thread. The dimension of the threaded part is indicated left above (1/2 inch). Additonal information is given in the note (1/4-20-NC-2). The first number of this note indicates the outside diameter of the thread (1/4 inch); the second number indicates how many threads there are per inch (20); the letters NC indicate the thread series (National Coarse); the last number indicates the class and tolerance (fit) of the thread (2 indicates free fit).

Specifications for manufacturing screws must include diamter, series, class of fit, and number of threads per inch.

There are several types of pitch series of threads which include:

1. National Coarse (NC).

2. National Fine (NF).

3. National Standard (NS).

4. Pipe.

National Standard and National Fine are t the most commonly used types of threads.

According to their fits, threads are classified as follows:

Class 1: Are not used on ordnance equipment. They are generally used on equipment where loose fit is not objectionable.

Class 2: Most widely used on general (not precision) equipment.

Class 3. Used only for precision tools and precision equipment (highgrade threads).

Class 4. Are hand-selected for best fit (precision threads).

The following are difinitions of some common terms used in connection with threads:

1. The pitch is the distance between two corresponding points on two adjacent threads, measured parallel to the axis.

2. The lead is the distance which a screw advances in one turn.

3. The major diameter of a thread is its largest diameter.

4. The minor diameter of a thread is its smallest diameter.

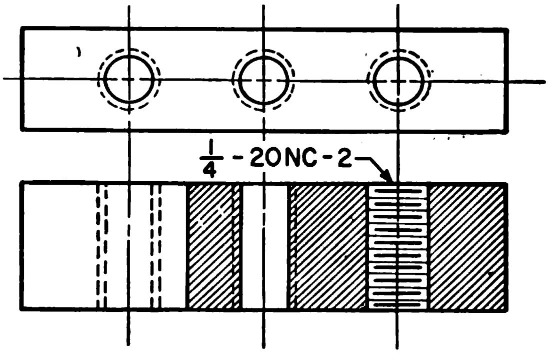
5. The crest is the top of the thread which represents the major diameter of the threaded part of a screw and the minor diameter of a nut.

6. The pitch diameter is the diameter of the threaded part of a screw which is cut by the surface of an imaginary cylinder at certain points, in order to equalize the width of the threads and the width of the spaces between the threads.

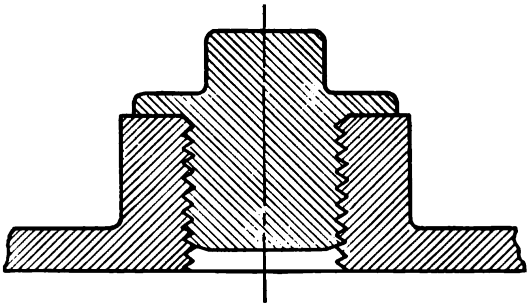
7. The root of a thread is the bottom surface of a thread which joins its adjacent sides.

8. The depth of a thread is the vertical distance measured from the creast of a thread to its root.

To draw internal threads, several kinds of symbols may be used. An example of internal thread symbols is shown in illustration at the top of the adjacent page.

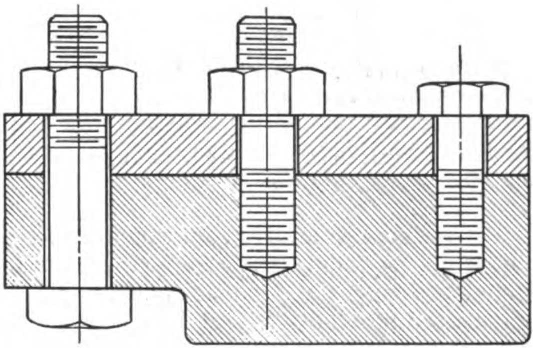


18. INTERNAL THREADS



20. BOLT, CROSS-SECTION

Bolts and studs may also be represented on drawings by outlines and symbols. (Refer to the accompanying illustrations.)



19. BOLTS AND STUDS

TOPIC 3: DRAWING VIEWS

You Are Now Going To Learn:

1. Types and purposes of views presented in drawings.

Discussion Points For This Topic Are:

1. Definition and use of perspective views.
2. Definition, use, and dimensioning of isometric views.
3. Definition, use, dimensioning, and interpretation of orthographic views.
4. Definition, types, and uses of sectional views.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10077B, Chapter 3, pages 22 through 28.
   2. Review NAVPERS 10077B, Chapter 3, pages 28 through 32.

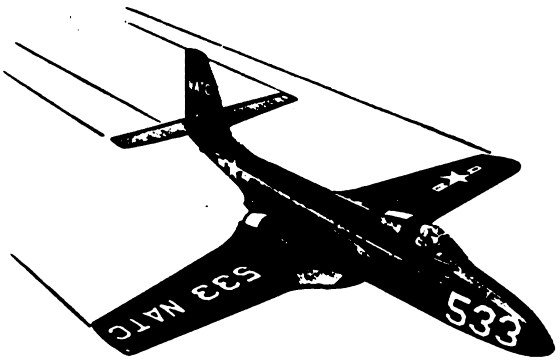
INFORMATION AND DISCUSSION:

Drawings are valuable visual aids used for showing complete assemblies or parts, their location, functions, or construction features.

Drawings may also be used as guides for disassembling and assembling complicated mechanisms or for presenting new types of equipment before they are manufactured.

Perspective Drawings:

Perspective drawings are similar to photographs. However, like photographs, they do not show the object in proper proportions. (Refer to the illustration in the adjacent column.)

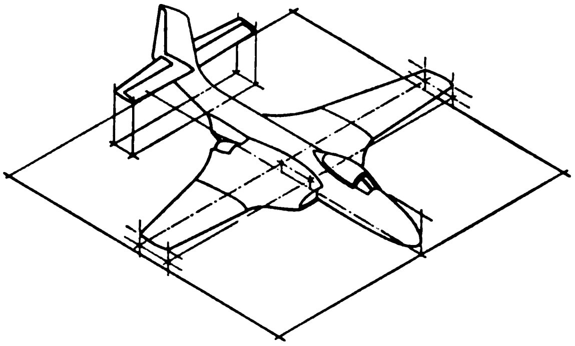


21. PERSPECTIVE VIEW

Isometric Drawings:

Isometric drawings are similar to perspective drawings, with the exception that the lines which are parallel on the object are also parallel on an isometric drawing. (If extended, parallel lines on an isometric drawing will never meet.)

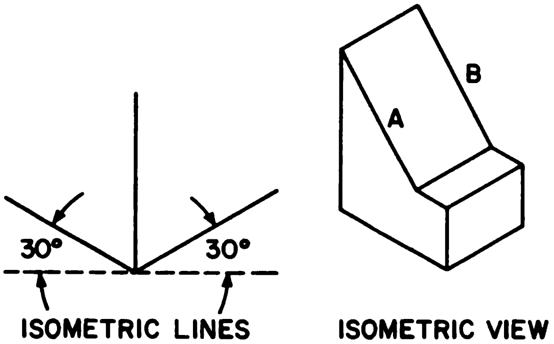
On an isometric drawing, three views of an object can be shown at once in proper dimensions, although the general appearance of the object is distorted. (Refer to the following illustration.)



22. ISOMETRIC VIEW PRESENTING THREE VIEWS OF OBJECT

The vertical and horizontal lines of an isometric drawing are called isometric lines. All horizontal and vertical lines on an isometric drawing show the object in proper proportions; the vertical lines of the object are shown vertically, but the horizontal lines are drawn at an angle of 30 degrees with the line of the horizon.

Refer to illustration which follows and note that all lines except A and B, have proper proportions because they represent the horizontal and vertical lines of the object. Lines A and B are not isometric lines; therefore their proportions are not correct.



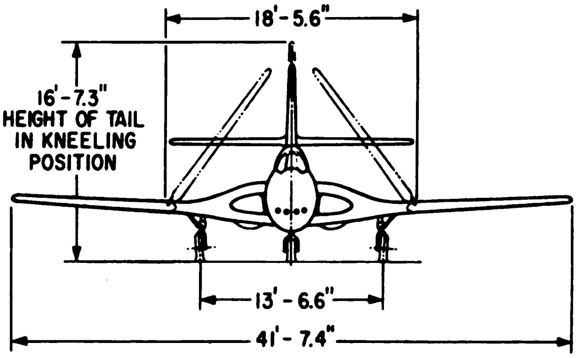
23. ISOMETRIC VIEWS PRESENTING PROPORTIONS OF LINES

Isometric drawings are used for the same purposes as other drawings. Isometric drawings may also be dimensioned. Blueprints of these dimensioned drawings may be used for representing simple objects. For showing complicated parts or structures, isometric drawings cannot be used alone; they can be used only as aids to supplement orthographic drawings.

Orthographic Drawings:

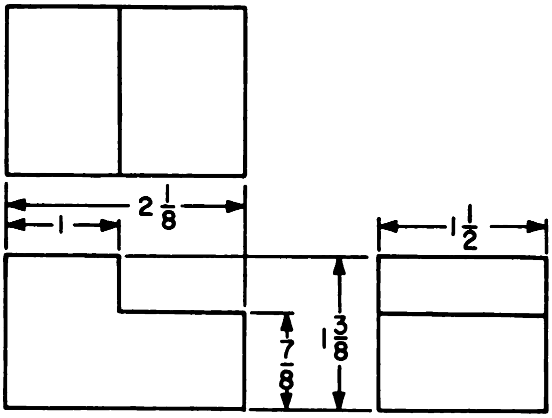
Orthographic drawings are used for furnishing complete information for construction and repair purposes. Since these drawings are accurate and represent the objects in their proper dimensions, they are the foundation of all construction blueprints.

NOTE: While studying an orthographic drawing, look only at one surface of the object (top, front, or side) at a time; this will help you to visualize the appearance of the whole object. To determine the correct shape and size of the surface, the line of sight must be perpendicular to all points of that surface, as illustrated by the figures which follow.



24. ORTHOGRAPHIC VIEW

25. COMPARISON OF ORTHOGRAPHIC VIEW WITH MODEL



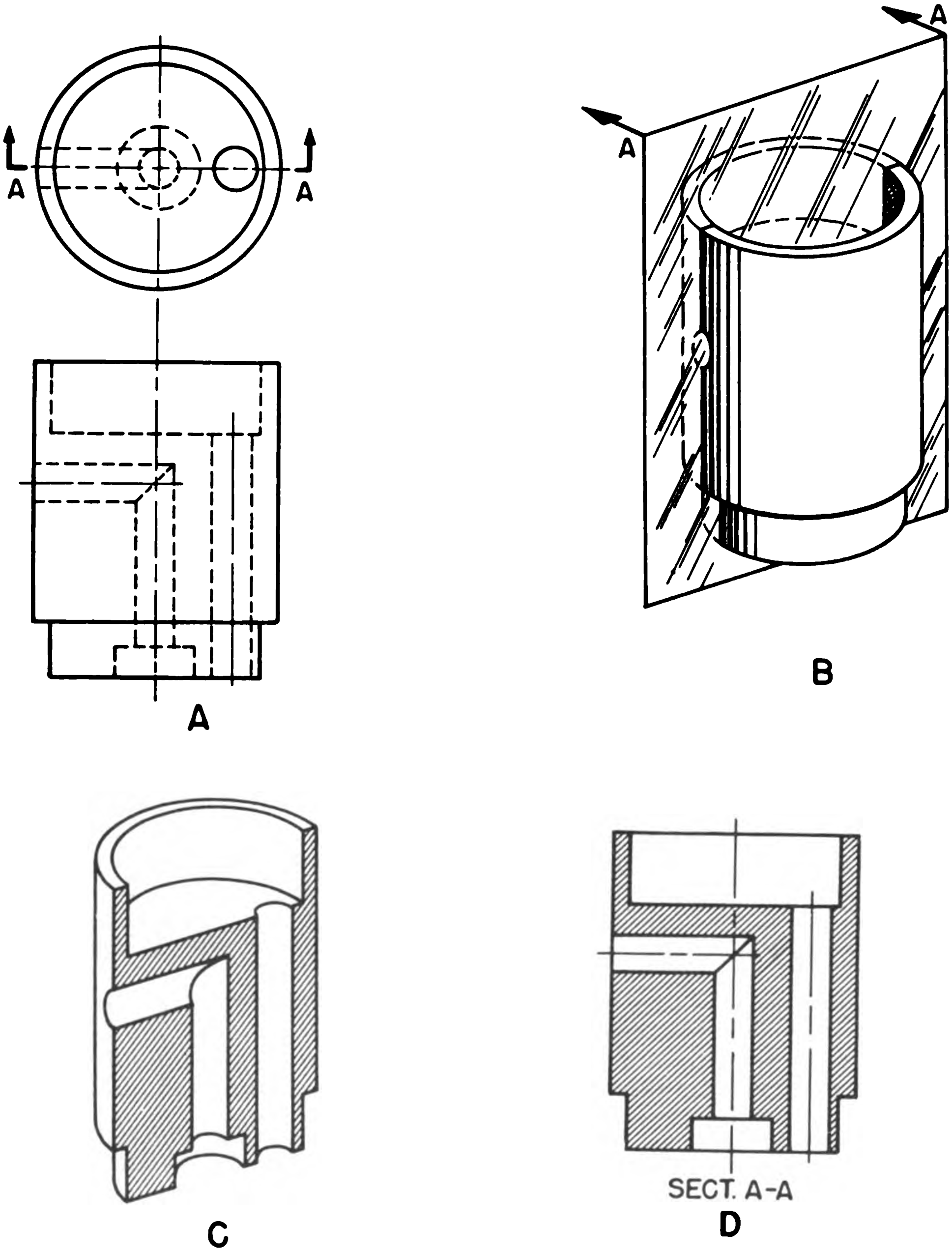
26. DIMENSIONING OF ORTHOGRAPHIC VIEWS

On orthographic drawings, the correct relationship of the various surfaces is maintained by proper arrangement of the views.

Sectional Drawings:

Sectional drawings reveal the inside of an object just as if it had been cut in half along the cutting plane. These drawings are used to ease understanding of the arrangement of complicated parts.

Refer to the illustration below, item A, and note that the cutting plane line AA shows where the imaginary cut has been made; the isometric view, item B, is presented as an aid for visualizing the cutting plane. In item B, the arrows point in the direction of the section view. Item C shows the inside of the



27. SECTIONAL VIEW

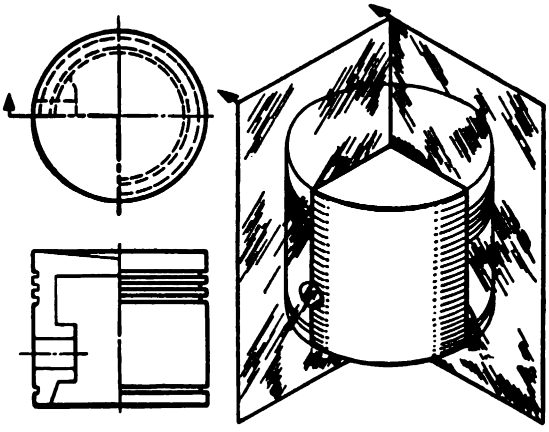
object as if it actually were cut in half. Item D presents an orthographic view of the same section as item C.

When sectional views are shown on drawings, the part that is cut by the cutting plane is marked by diagonal parallel lines. The draftsman's definition for drawing these lines is crosshatching. When more than one part is shown on one view, each part which is sectioned is crosshatched with a different slant of lines.

Half-section views are used to present objects which are symmetrical outside and inside.

On half-section views, one half of the object is shown sectioned, and the other half is shown complete. If the object is round, it is cut into two equal parts, and these two halves are again cut in equal halves. One of these quarters is then removed to show the cutting perspective.

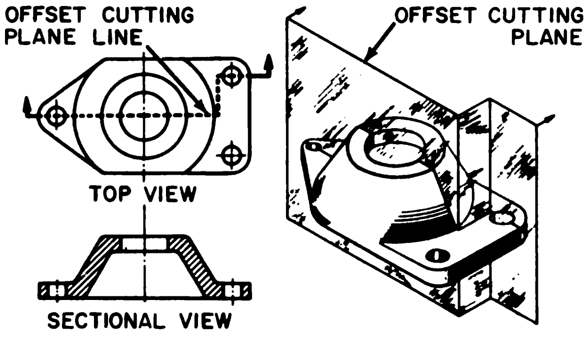
If the cutting plane had extended along the entire diameter of the cylinder, a full section could be shown. In the following illustration, the cutting plane extends only half of the diameter; therefore the drawing is called a half-section view.



28. HALF-SECTION VIEWS

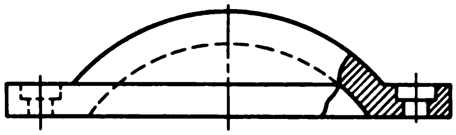
In the view of an offset section, there is a joggle, or offset, in the cutting plane.

In the top view of the illustration shown below, the cutting plane is offset to show the hole on the right side of the sectional view.



29. OFFSET SECTION VIEWS

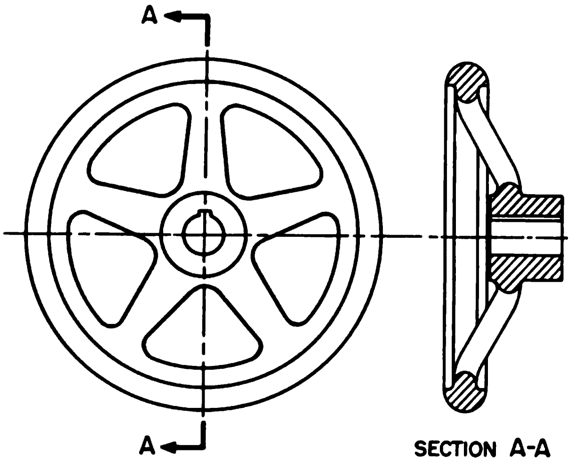
The broken-out section of a small area can be shown by peeling back (removing) the outside surface. The broken-out section provides a good view of the inside of the counterbored hole, as illustrated by the accompanying figure.



30. BROKEN-OUT SECTION VIEW

Alined section views are used when other sectional views might be misleading. Parts, like ribs or spokes, are then shown as if they were rotated into or out of the cutting plane.

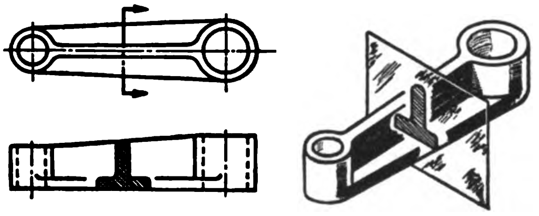
In the illustration below the spokes in section AA are not sectioned. If the spokes were sectioned, the first impression would be that the wheel consists of a solid web (not of spokes).



31. ALINED SECTION VIEWS

To eliminate extra views of rolled shaped ribs, revolved section views are used. These are actually drawings within drawings, but they clearly define the shape of objects at certain cross-sections, stations, or points.

In the illustration below the objects are revolved so that they can be looked at head on. Because of this feature (revolving), the sections are called revolved sections.



32. REVOLVED SECTION VIEWS

TOPIC 4: NOTES, SPECIFICATIONS, AND DIMENSIONING

You Are Now Going To Learn:

1. Location, contents, and purpose of notes and specifications used on drawings.
2. Dimensioning of drawings.

Discussion Points For This Topic Are:

1. Title block, its location and contents.
2. Supplementary block, its location and contents.
3. Application block, its location and contents.
4. Security classification block, its location and contents.
5. Revision block, its location and contents.
6. Special blueprint notes:
    a. Bill of material.
    b. Specifications and standards.
    c. Heat treatment.
    d. Surface finish.
    e. Part identification numbers.
7. Dimensioning.
8. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study NAVPERS 10077B, Chapter 2.

INFORMATION AND DISCUSSION:

In accordance with military standards, the major part of the information and notes applicable to a particular print is located in the lower right-hand corner of the drawing.

Title Block:

The title block is located nearest to the right edge of the drawing and contains the following information:

1. Title (name) of drawing.
2. Drawing number.
3. Name of bureau that authorized drawing.
4. Name of contractor or Navy activity that prepared drawing.
5. Initials of draftsman, initials of person who checked drawing, and initials of supervisor or senior engineer, with corresponding dates.
6. Authentication and date.
7. Scale of drawing.
8. Unit weight.
9. Code identification number.

All drawings are identified by numbers which appear in the number block, in the lower right-hand corner of the title block. In addition, drawing numbers may also be shown in other places; for example, near the top border line, in the upper right-hand corner, or at both ends of the reverse side of a drawing so that the number is visible when the drawing is rolled.

The numbers are used to facilitate identification of drawings. If a blueprint consists of more than one sheet and each sheet has the same drawing number, this information is included in the number block, indicating the number of the particular sheet and the number of sheets in the series.

BUWEPS drawing numbers are assigned to Navy activities and to contractors by the Central Technical Documents Office, U. S. Naval Ordnance Plant, Louisville, Ky.

To become official, all drawings must be authenticated and dated. A drawing is considered to be authenticated if it is signed by the proper authority. Drawings may be signed by commanding officers of Navy activities, or by Navy inspectors at contracting activities, or by persons who have authority delegated by commanding officers or Navy inspectors.

The scale of a drawing is given in the title block. The scale indicates the proportion of the drawing to the actual size of the object shown in the drawing. The proportion is usually stated as 1" = 2", 1" = 12", etc; or as 1 : 2, 1 : 12, etc.; or as $\frac{1}{2}$, $\frac{1}{12}$, etc.; but may also be indicated as full size, one-half size, etc.

Selection of scale depends upon the size of the object to be drawn and the space available on the sheet. To provide a complete view of a large object, the object is shown reduced; to provide a better view of a very small part, the part is shown enlarged.

If the draftsman uses a scale of 1" = 2", the object shown on the drawing is reduced to one-half of its actual size; if the scale is 3" = 1", the object shown is enlarged three times its actual size.

To determine the actual size of an object shown on a drawing, use the dimensions provided. They are correct and always remain the same. Do not measure the drawing, because

1. If the draftsman has made a mistake in the measurements, you will repeat it.
2. The print might have been reduced (might be smaller than the original drawing), and in the process of reduction, errors could have been introduced.
3. You may forget to consider the scale of the drawing.
4. Paper may stretch or shrink due to humidity changes.

The unit weight is the weight of the item shown on the drawing. The weight is given in pounds.

The code identification number designates the bureau that authorized the print. For instance, BUORD prints were designated 80066; BUWEPS prints are designated 10001.

Supplementary Block:

The supplementary block is located left of the title block and contains the following information:

1. General tolerances applicable to the item shown on the drawing, except the tolerances given in notes on the drawing.
2. Type, class, and grade of material furnished for the end product.

When the space provided in the supplementary block is insufficient for listing all information, a special note is included within the field of the drawing.

Application Block:

The application block is located next to the supplementary block. The application block contains further identification of the part or the assembly shown on the drawing. This block contains the drawing number of the next higher assembly and the applicable list of drawings (LD).

Security Classification Block:

The security classification block, used only on classified drawings, is located next to the application block. The security classification block indicates the classification of the drawing and contains a warning note. The classification is also repeated several times around the border of the drawing.

Revision Block:

The revision block is always located on the right side of the print, usually in the upper corner. The revision block contains a revision letter, a brief description of the revision, and the date and initials of the person who approved the revision.

Special Blueprint Notes:

Special blueprint notes, which do not require leaders, are located outside of the view of the object, at either end of the drawing. These notes are usually numbered in consecutive order and may be referred to by numbers within the field of the drawing.

The following types of notes are frequently found on drawings:

1. Bill of material.
2. Specifications and standards.
3. Heat treatment.
4. Surface finish.
5. Part identification numbers.

A special box on the drawing may contain a list of stock items required for assembling a unit or a complete assembly. This list is called bill of materials and contains a listing of the type, size, and specification of stock.

The bill of material for an assembly drawing frequently also includes a list of standard parts. Many items of common use, such as machine bolts, screws, turnbuckles, rivets, pipe fittings, and valves, have been standardized by the Army, Navy, and Air Force. Each standardized item is listed by a number which is preceded by the letters AN. For example, a wing-nut has an Army-Navy specification number of AN 350; a flat-head sheet metal screw is listed as AN 531.

> NOTE: Always use the material specified. Never substitute material without proper authorization. The material specified is selected by an engineer because it meets the requirements; it is the best material for that particular job. When the material specified is not available, substitution of material can be authorized only by an engineer or a man who has the authority of an engineer for that particular job.

The Index of Navy Department Specifications, published quarterly by the Bureau of Supplies and Accounts, contains interim bureau specifications and joint Army-Navy, Navy, and Federal specifications used by the Navy.

The specification notes and standard notes of a drawing refer only by number to the applicable specifications or standards. To understand the note, it is usually necessary to obtain the particular specification or standard.

Navy Department Specifications are approved by all bureaus concerned and are administered by the Navy Department Specifications Board. The specifications are identified by standard specification numbers of the Navy Department. These numbers consist of the standard stock class number, the first letter of the material, and a serial number.

Joint Army-Navy Specifications have been developed and adopted for use by the Department of Defense. Material listed according to these specifications is identified JAN or MIL, followed by the first letter of the material and a serial number. (For example: MIL-F-00036 is a type of welding flux.)

Federal Specifications point out the characteristics of materials and supplies used jointly by the Navy Department with other Government agencies. All Federal specifications used by the Navy are listed in the Index of Navy Department Specifications.

General Specifications for Inspection of Material list the requirements which have to be fulfilled by Navy contractors.

The notes or specifications on a blueprint may point out the type of heat treatment the material requires, since practically all metals require heat treatment in the manufacturing process. It is frequently necessary to remove the temper from a piece of metal, so the metal can be machined according to specifications. After this operation, the metal must be rehardened. To determine the type of heat treatment required and at which point of processing the heat should be applied, reference should be made to the specifications in the note.

Finish marks are used to indicate which surfaces must be finished by machining. Machining improves the appearance of a surface and provides a closer fit of the mating parts. During the finishing process, the required limits and tolerances must be observed. (Finishing by machining, however, should not be confused with finishing processes in which paints, enamel, grease, chromium plating, and similar coatings are used.)

An identification number of a part shown on a blueprint is not only an identification number of the part, but is also the identification number of the detail blueprint that shows this part.

Sometimes two parts are shown on one detail print; when this happens, both parts have the same basic number plus individual numbers (such as 34105-1 and 34105-2). These individual numbers are also used to identify right-hand and left-hand parts.

Dimensioning:

Dimensioning is used to determine the size and location of certain components or points of the object shown on a print and to define their particular limits and tolerances. Dimensioning and tolerancing of military prints are performed according to MIL-STD-8A.

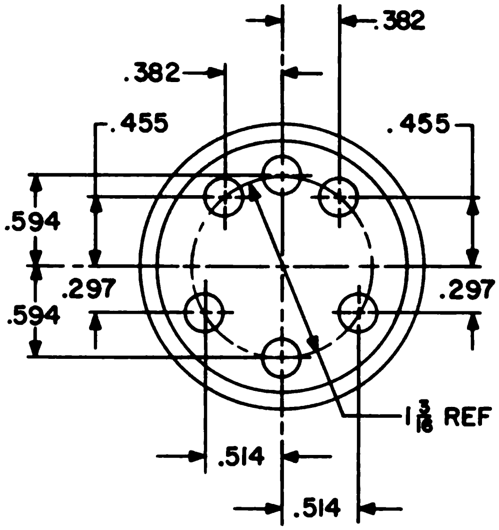
The size and location may be determined by either one of the two following methods:

1. Rectangular dimensioning - used to locate points by means of linear dimensions parallel to reference lines. (See the illustration at the top of the adjacent column.)

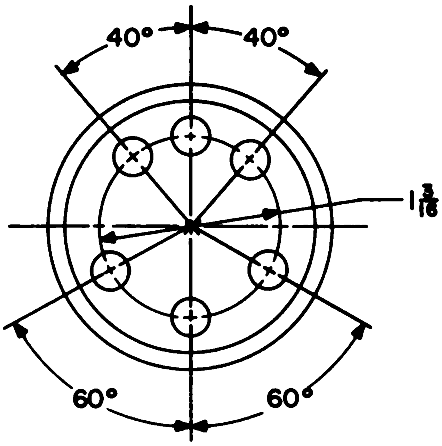
2. Angular dimensioning - used to determine the position of a point, line, or surface by means of angular references. (See the second illustration in the adjacent column.)

Both methods of dimensioning may be used on the same print. However, the same surface or point must be measured by only one method. Wherever tolerances are close (very small), the rectangular method is generally preferred to the angular.

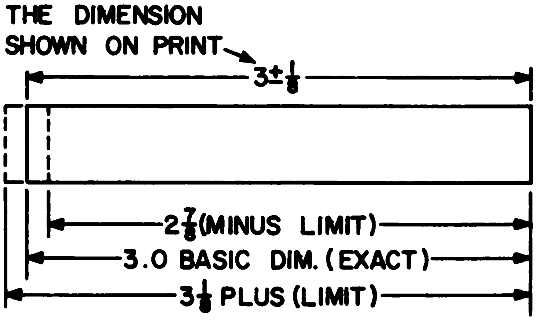
A dimension on a print gives the ideal size of the object on a drawing. This dimension is called basic dimension. However,



33. RECTANGULAR DIMENSIONING



34. ANGULAR DIMENSIONING

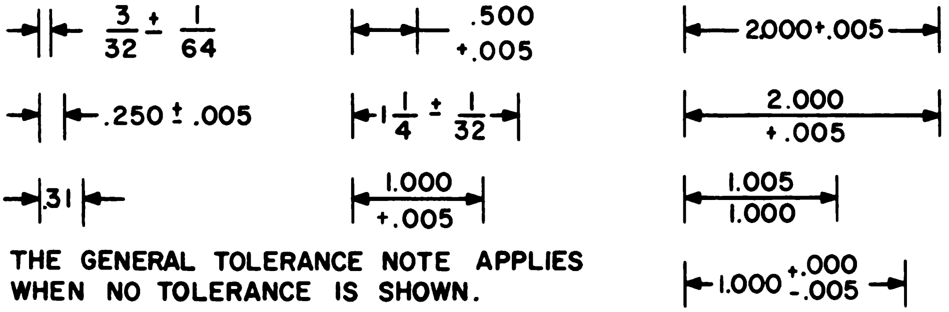


35. BASIC DIMENSIONS, LIMITS, AND TOLERANCES

engineers realize that it is almost impossible to achieve absolute accuracy; therefore, the possible variations from the basic dimension are figured out and are included on most prints. These leeways are called limits and tolerances.

Limits are the allowed maximum and minimum dimensions of an object; tolerances are allowed variations from or differences between the maximum and minimum limits. The tolerance can be found by subtracting the minus-limit from the plus-limit. (The tolerance on the illustration in the middle of the preceding page is 1/4".)

Limits and tolerances can be shown on a print in various manners. (Refer to the illustration below.)



36. LIMITS AND TOLERANCES

TOPIC 5: ORDNANCE DRAWINGS

You Are Now Going To Learn:

1. Definition of ordnance drawings.
2. Types and purpose of following:
   a. Ordnance drawings.
   b. Ordnance sketches.
   c. Lists of drawings.

Discussion Points For This Topic Are:

1. Types and purpose of ordnance drawings.
2. Types and purpose of ordnance sketches.
3. Types and purpose of lists of drawings.
4. Classification of ordnance drawings.
5. Procurement of prints, sketches, and lists of drawings.
6. Review and summary.
7. Section review.

INFORMATION AND DISCUSSION:

An ordnance drawing is an officially approved (signed) drawing (blueprint) prepared for the Bureau of Weapons.

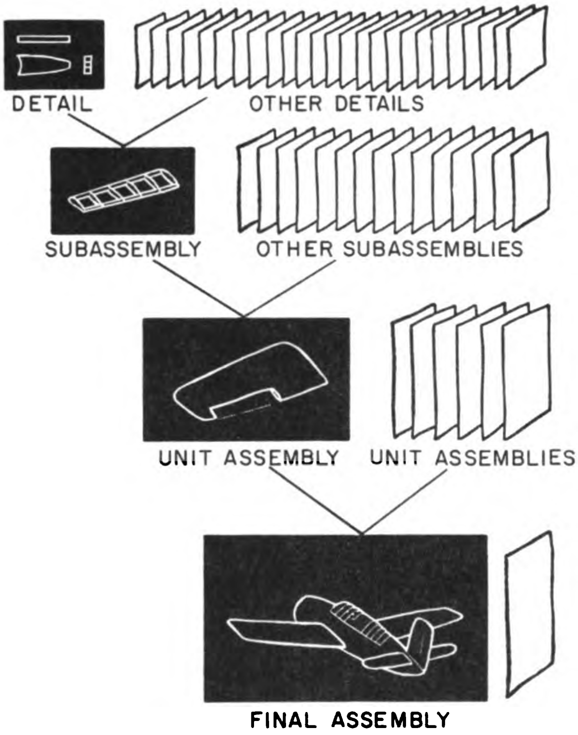
There are various types of ordnance drawings. A typical assembly drawing is shown in the illustration at the top of the adjacent column.

Final Assembly Drawing:

A final assembly drawing shows the relationship and the identifying numbers of all parts and/or subassemblies of an entire unit. When parts have already been identified on the subassembly drawings, the part numbers are not shown again on the final assembly drawing.

Unit Assembly and Subassembly Drawing:

The unit assembly and subassembly drawings show a group of related parts of complicated ordnance equipment. These drawings are used when it is impossible to show all components of an assembly on one drawing.



37. TYPICAL ASSEMBLY DRAWING

Detail Drawing:

A detail drawing shows the details of a single item of the equipment. In a detail drawing, all characteristics of the item (dimensions, tolerances, types of materials, surface finishes, and protective coatings) are clearly defined.

Installation Drawing:

An installation drawing is an outline drawing showing the general configuration of the equipment and furnishing all information required for installation of the equipment onboard ship.

Outline Drawing:

An outline drawing defines the external contour of an item, usually by showing the projected views on three perpendicular planes.

Arrangement Drawing:

An arrangement drawing is an outline drawing in any perspective. This type of drawing is used for familiarization with equipment and for preliminary studying of its cofunctions with other equipment.

Personnel Arrangement Drawing:

A personnel arrangement drawing is an outline drawing that shows the approximate positions of the operating personnel.

Electrical Schematic Diagram:

An electrical schematic diagram is a drawing that shows electrical circuits and, by use of symbols, indicates the location of associated equipment parts, to facilitate troubleshooting of circuits.

> NOTE: An electrical schematic is also called Elementary Wiring Diagram and sometimes bears this title on ordnance drawings.

Wiring Diagram:

A wiring diagram is a drawing that shows the wiring connections within an assembly, a subassembly, an electronic set, or an electrical system.

Interconnection Diagram:

An interconnection diagram is a drawing that shows the wiring connections between subassemblies. This type of drawing is also called a cabling diagram.

Mechanical Schematic Diagram:

A mechanical schematic diagram is a drawing that shows the operational sequence of a group of mechanical parts that are related in the performance of a particular function.

Piping Diagram:

A piping diagram is a line-drawing that shows the piping connections of units or parts. Piping diagrams also may show the sequence of fluid flow in the equipment.

Hydraulic Schematic Diagram:

A hydraulic schematic diagram is a drawing that shows the functional components of hydraulic assemblies or systems. Hydraulic schematics also may show relationship of assemblies, subassemblies, or mechanical components.

> NOTE: The many and various applications of hydraulics have necessitated the use of a standard symbol system which is called J. I. C. (Joint Industrial Congress) system.

Lubrication Charts:

A lubrication chart is a drawing showing the various points which require lubrication. A lubrication chart also specifies the type and frequency of lubrication.

Ordnance Sketches:

Ordnance sketches are preliminary drawings prepared during the research, experimentation, or development phases of equipment, under BUWEPS contract or by task assignment. Naval activities that desire to use numbers from a unified series may request the assignment of blocks of BUWEPS sketch numbers. If the sketch is prepared on a BUWEPS format, the word drawing is deleted and replaced by the abbreviation SK which precedes the number.

List of Drawings:

A list of drawings (LD) is a list of ordnance equipment parts and all documents (prints, sketches, other LD's, specifications, and standards) applicable to ordnance equipment. LD's can be of the following types:

1. Principal LD:

A principal LD is prepared for each system of Naval ordnance equipment. It includes a list of major assemblies, subassemblies, individual components and accessories, also applicable documents.

2. Index to LD:

An index to an LD is a complete list of all lists of drawings (LD's) applicable to one major system of ordnance equipment.

3. Subordinate LD:

A subordinate LD is a list of drawings and parts applicable to subassemblies. These drawings and parts are not listed in the principal LD.

4. Supplementary LD:

A supplementary LD is a list of drawings or items (tools and test equipment) which provides additional information not contained in other LD's.

Not all drawings, sketches, or lists of drawings, whether prepared by a naval activity or a private contractor, are classified. However, if they require security classification, they are classified in accordance with procedures defined in the current Department of the Navy Security Manual for Classified Information, OPNAV Instruction 5510.1. Drawings are classified as follows:

1. TOP SECRET.
2. SECRET.
3. CONFIDENTIAL.

Drawings, sketches, and LD's may be procured from the Central Technical Documents Office, U. S. Naval Ordnance Plant, Louisville 14, Kentucky.

QUIZ SHEETS:

1. Phototracings taken of a pencil drawing are regarded as master drawings.

   True__________or False________.

2. An ordnance drawing is not considered official until it has been

   a. Signed.
   b. Delivered.
   c. Blueprinted.
   d. Traced.

3. A detail assembly drawing shows

   a. One assembly.
   b. One subassembly.
   c. One object.
   d. Two or more objects.

4. Ordnance sketch numbers are preceded by the letters

   a. DR.
   b. SK.
   c. SEC.
   d. LD.

5. Ordnance sketch numbers can only be assigned by BUWEPS.

   True__________or False__________.

6. Technical sketches for job orders do not have to meet established standards.

   True__________or False__________.

7. List the four types of LD's available:

   a.______________________________
   b.______________________________
   c.______________________________
   d.______________________________

8. According to OPNAV Instruction 5510. 1, ordnance drawings are classified

   a. CONFIDENTIAL.
   b. SECRET.
   c. TOP SECRET.
   d. All of the above.

9. Simplified conventions (material symbols) do not indicate specific kinds of materials.

   True____________or False________.

10. Draw the symbols for the following:

    a. Outline:
    b. Centerline:
    c. Hidden line:
    d. Phantom line:

11. On drawings, the designations, dimensions, and notes are tied to the corresponding parts by a

    a. Centerline.
    b. Leader.
    c. Hidden line.
    d. Phantom line.

12. Short-break lines are used to indicate that a part on the print has been shortened.

    True____________or False________.

13. Indicate which thread fit is the most commonly used:

    a. Class 4.
    b. Class 3.
    c. Class 2.
    d. Class 1.

14. A perspective view of an object is similar to a photograph of same.

    True____________or False________.

15. All vertical and horizontal lines on an isometric drawing represent the true dimensions of an object.

    True or False

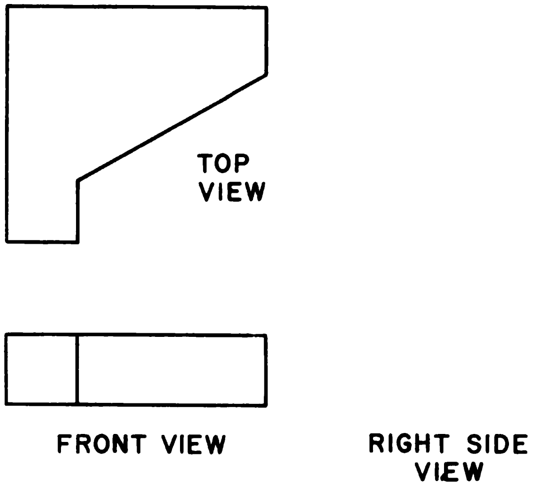
16. Lines representing horizontal lines on isometric drawings are drawn at an angle of:

    a. 15 degrees.
    b. 20 degrees.
    c. 30 degrees.
    d. 45 degrees.

17. Orthographic views are accurate and indicate true shape and size of an object.

    True__________ or False__________

18. Draw the missing view:



19. Crosshatching is used on sectional views.

    True__________or False__________

20. Where is the revision block usually located on a blueprint?

    a. Upper right corner.
    b. Upper left corner.
    c. Lower right corner.
    d. Lower left corner.

21. Indicate agency which publishes an index of Navy Department specifications:

    a. Bureau of Weapons.
    b. Naval Weapons Plant.
    c. Bureau of Supplies and Accounts.
    d. Naval Ordnance Plant, Louisville, Kentucky.

22. When tolerances are very minute (small), which type of dimensioning is preferred?

    a. Angular.
    b. Rectangular.
    c. Straight line.
    d. Circular.

Accuracy of notes checked by instructor:

Date______________________________

Trainee's initials________________________

Section 4

HAND TOOLS

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Basic Rules Concerning Use of Repair Equipment	70
2.	General Purpose Tools	72
3.	Measuring Tools and Gauges	74
4.	Shaping and Cutting Tools	76
5.	Soldering	78
6.	Drilling and Reaming	80
7.	Thread Cutting	82
8.	Tube Fabricating Tools	84
9.	Special Tools	86
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TOPIC 1: BASIC RULES CONCERNING USE OF REPAIR EQUIPMENT

You Are Now Going To Learn:

1. General information about repair equipment.
2. The safety regulations to be observed while working with repair tools.

Discussion Points For This Topic Are:

1. Selection of proper tools.
2. Types of repair tools.
3. Planning of work.
4. Basic rules applicable to repair equipment.
5. Safety precautions.
6. Review and summary.

INFORMATION AND DISCUSSION:

Each technician must be familiar with the techniques required for repair and maintenance of ordnance equipment. He must know which tool to select and how to perform a job. Whether he is going to repair a guided missile launching system, a gun, a power drive unit or adjust equipment for proper operation, he must possess basic skill in laying out the job, in measuring, cutting, testing, checking and other related procedures.

Tools can be classified as follows:

1. Handtools (general purpose tools).
2. Power tools.
3. Measuring tools and gauges.
4. Special tools

Handtools are hand-powered and hand-operated. They are designed to perform mechanical operations. Examples of typical handtools are hammers, screwdrivers and saws.

Power tools can be either electrically or pneumatically powered and are hand-operated. They are designed to save time and manpower. Examples of typical power tools used by gunner's mates are soldering guns, drills, and grinders.

Measuring tools and gauges are used for measuring and for layout work. Accurate measurements are essential for proper fitting and trouble free equipment operation. To test and check the various types of power equipment, special gauges are used. The measuring tools and gauges range from a simple wooden or steel ruler to highly intricate micrometers.

Special tools are used only for one purpose and only on one type of equipment. They are supplied by BUWEPS. Instructions for their proper use are provided in the OP applicable to the equipment.

Before a job is started, all work procedures should be planned step by step (on paper, if necessary). The proper tools should be selected to complete the job with the highest degree of accuracy in the shortest time.

Tools which are not actually in use should be kept in their proper places. After a job is completed, all tools should be properly stored.

Basic Rules Applicable to Repair Equipment:

1. The quality and type of all tools shall conform with Navy standards.
2. All tools in active use shall be properly maintained. Defective tools shall be returned to the toolkeepers.
3. Portable electric and pneumatic tools shall be kept in the best condition possible. Switches, control valves, electric cord, and hose connections shall be frequently checked.
4. To prevent damage, tools shall be carefully handled. They shall not be

piled in drawers or dropped on hard surfaces. Faulty tools shall not be used, since a cracked hammer handle, a rounded screwdriver tip, or a punch with improper point or mushroomed head may cause serious accidents.

5. To increase leverage, extensions on tool handles shall not be used.

Safety Precautions:

It is extremely important that all persons working with tools realize the possibility of injury. The following safety precautions are, therefore, included to prevent or minimize personal injury:

1. Familiarize yourself with the composition and consistency of the material with which you will be working and select the proper tool. Do not use a tool for other purposes than originally intended. For instance, a screwdriver is designed to loosen or tighten screws. Do not use it as a chisel or prybar.
2. Use only sparkproof tools near explosives or in an explosive atmosphere.
3. Use torches and soldering irons with extreme care to prevent burns and explosions. Place soldering iron so that the hot point cannot come in contact with flammable material or with your body.
4. Always wear goggles when chipping metal and when grinding edges of tools.
5. Before using the tools, make sure that all tool handles are securely attached.
6. For electrical work, use only tools with insulated handles.
7. Exercise extreme caution when handling edged and pointed tools. Do not carry them in your pocket. When you use a knife (except a spoke shave or draw knife), always cut away from your body.
8. Do not grasp a tool handle in such a way that your fingers can be pinced or jammed if the tool slips.
9. Hold chisels, punches, and drifts in the safest way possible, between thumb and other four fingers; on horizontal cuts, hold your palm up.
10. When working with sledge hammers on chisels or other similar shock tools, use a tool holder to prevent injury in the event that the sledge misses the tool.
11. Securely tighten the drill chucks with the key provided. Do not use wrenches or pliers to tighten a chuck.
12. Do not use an oily or greasy tool, it may slip out of your hand and cause injury.
13. Make sure that the work to be cut, sheared, chiseled, filed, etc. is steadied and secured to prevent the tool from slipping.
14. Hold driving tools correctly to prevent them from slipping off the work surface.
15. When using jacks to lift heavy objects, use blocking or other supports to prevent the object from falling if the jack slips.

NOTE: Component repair techniques will be covered during the course of instruction.

TOPIC 2: GENERAL PURPOSE TOOLS

You Are Now Going To Learn:

1. Types and use of general purpose tools.

Discussion Points For This Topic Are:

1. Hammers.
2. Screwdrivers.
3. Pliers.
4. Wrenches.
5. Torque wrenches.
6. Punches.
7. Review and summary.

ASSIGNMENT:

A. Reference publications:

  1. Study NAVPERS 10085A, pages 1 through 9, and 24 through 28.
  2. Optional reading list:
     a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed for this topic are thoroughly covered in the reading assignment.

TOPIC 3: MEASURING TOOLS AND GAUGES

You Are Now Going To Learn:

1. Types, use, and care of measuring tools and gauges.

You Will Acquire Skill In:

1. Reading the machinst steel rule.
2. Using inside and outside calipers.
3. Reading vernier scale micrometers.
4. Using feeler gauges.

Discussion Points For This Topic Are:

1. Common machinist steel rules.
2. Calipers.
3. Micrometers.
4. Dial indicators.
5. Feeler gauges and depth gauges.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10085A, pages 28 through 38, 40 through 44, 90 through 102, and 116 through 119.
   2. Optional reading list:

      a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment. While studying, pay particular attention to reading of micrometers.

PERFORM THE FOLLOWING OPERATIONS:

1. Use common steel rules.
2. Use various types calipers.
3. Take micrometer readings.

TOPIC 4: SHAPING AND CUTTING TOOLS

You Are Now Going To Learn:

1. Types, use, and care of shaping and cutting tools.

Discussion Points For This Topic Are:

1. Chisels.
2. Hacksaws.
3. Files.
4. Hand snips.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study NAVPERS 10085A, pages 10 through 14, 150 through 152, and 155 through 159.
2. Optional reading list:
   a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment. While studying, pay particular attention to the description of files.

TOPIC 5: SOLDERING

You Are Now Going To Learn:

1. Types, use, and care of flux, solder, and soldering equipment: coppers, irons, and guns.

Discussion Points For This Topic Are:

1. Soldering equipment:
    a. Electric irons.
    b. Guns.
2. Flux.
3. Solder.
4. Soldering procedures.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study NAVPERS 10085A, pages 188 through 194.
2. Optional reading list:
    a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 6: DRILLING AND REAMING

You Are Now Going To Learn:

1. Types, use, and care of drilling and reaming tools.

Discussion Points For This Topic Are:

1. Drills.
2. Twist drills.
3. Reamers.
4. Countersinks.
5. Counterbores.
6. Drill gauges.
7. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10085A, pages 14 through 16, 111, 133, 147 through 150, 162, 163, 171, and 172.

   2. Optional reading list:

      a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 7: THREAD CUTTING

You Are Now Going To Learn:

1. Types, use, and care of thread cutting tools.

Discussion Points For This Topic Are:

1. General information about threads.
2. Screw pitch gauges.
3. Taps.
4. Dies.
5. Tap extractors.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

  1. Study NAVPERS 10085A, pages 44 through 49, 99, 101, 163 through 172, and 185 through 188.
  2. Optional reading list:
     a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment. While studying, pay particular attention to description of taps and dies.

TOPIC 8: TUBE FABRICATING TOOLS

You Are Now Going To Learn:

1. Types, use, and care of tube fabricating tools.

Discussion Points For This Topic Are:

1. Tube cutting.
2. Tube flaring.
3. Tube bending.
4. Tube fitting.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

    1. Study NAVPERS 10085A, pages 54, 56, 57, 175, and 183 through 185.
    2. Optional reading list:
        a. TM9-243.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 9: SPECIAL TOOLS

You Are Now Going To Learn:

1. Types, use, and care of special ordnance equipment tools.

Discussion Points For This Topic Are:

1. Gasket cutters.
2. Bearing scrapers.
3. Grease guns and grease pumps.
4. Bearing and gear pullers.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study NAVPERS 10085A, page 28.
2. Study TM9-243, pages 123 through 129 and 162 through 166.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment, except for grease guns which are discussed in the following text.

Grease guns are manufactured in many shapes and sizes and can be operated by power or by hand. Normally, gunner's mates will have more use for the hand-operated grease gun than for the power-operated gun.

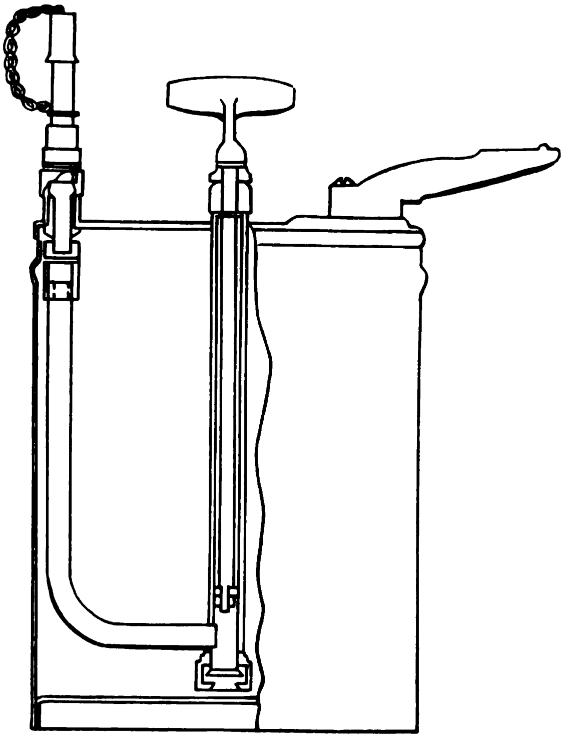
Depending on the method used for loading, grease guns are divided into two types. One type is loaded by removing the cap which contains the handle and stem and, by use of a paddle or spatula, filling the body of the gun with grease. This loading method exposes the lubricant to dirt and moisture and is usually messy.

The other type of hand-operated grease gun is loaded by removing a cap nut from the end of a hollow handle and forcing grease through the handle with a hand gun loader. This loading method is faster and cleaner.

Nozzles for various types of fittings may be attached to hand-operated grease guns.

The lever operated hand grease gun is a recent type of gun. It performs better than the Zerk type.

The hand gun loader (refer to illustration below) is a 25 pound metal container equipped with a hand-operated pump. Pump fittings mate with the grease gun handle opening.



38. HAND GUN LOADER

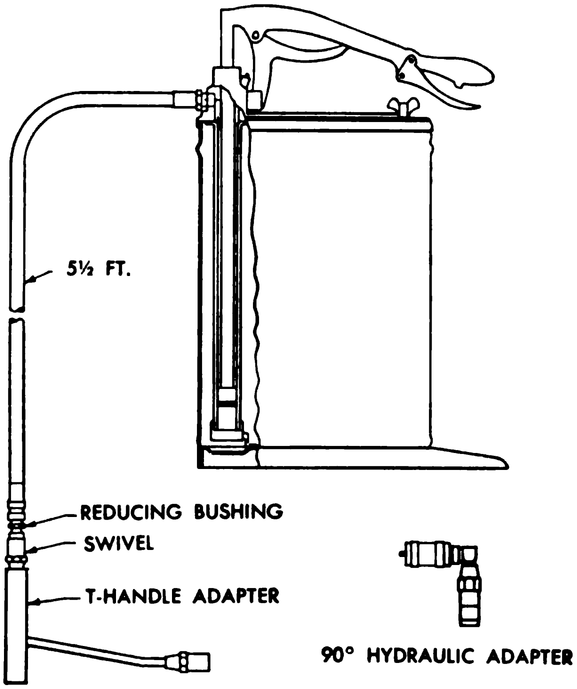
The bucket type lubricant pump has a loader adapter and loader valve which are used during loading of a grease gun. The loader delivers lubricant only when the grease gun is placed on the loader valve. This type of loading protects the lubricant from contamination and provides an extra supply of lubricant when the supply in the gun is expended.

The bucket type hand-operated lubricating pump (refer to illustration in the adjacent column) should be used for lubrication requiring large quantities of grease. The bucket-type pump holds a 25 pound supply of lubricant and is lever operated. Supplied with the pump are a 10 foot hose with a hydraulic T-handle adapter and a 90° adapter for working in cramped spaces. Various couplers and adapters may be attached to the hose for use on different types of fittings.

It would be ideal to have a grease gun for each type of lubricant to be used on a gun or mount. However, this is seldom, if ever, possible. Therefore, grease must be removed from the gun when several types of grease are used to complete lubrication. A good practice to follow is to be sure that there is no grease left in the gun before it is to be used for another type of grease.

PERFORM THE FOLLOWING OPERATIONS:

1. Cut round gaskets from sheet stock.



39. HAND-OPERATED GREASE PUMP

TOPIC 10: METAL FASTENERS

You Are Now Going To Learn:

1. Various types of metal fasteners and their uses.

You Will Acquire Skill In:

1. Identifying various types of metal fasteners.

Discussion Points For This Topic Are:

1. Screws.
2. Bolts.
3. Nuts.
4. Washers.
5. Keys and pins.
6. Rivets and rivet sets.
7. Review and summary.
8. Section review.
9. Written test.

INFORMATION AND DISCUSSION:

Metal fasteners are used extensively onboard ship for maintaining and repairing mechanisms and installations. In this topic the various types of metal fasteners will be discussed.

Screws:

Small screws, used for the assembly of metal parts, are generally called machine screws. They are usually screwed into holes that have been tapped with matching threads, but may also be used with square or hex nuts.

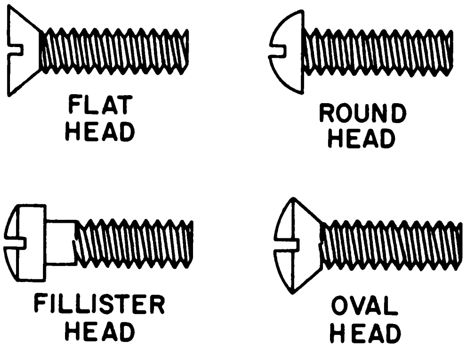
Most machine screws are made of steel or brass and may be chromium-or cadmium-plated to prevent corrosion. For special purposes, machine screws are manufactured of aluminum or stainless steel. The latter (stainless steel) are very strong and have a high resistance to the corrosive action of salt water.

Since screws are made with a wide variety of lengths, diameters, and head shapes, a complete description of a machine screw must include the following features:

1. Length in inches.
2. Gauge No. and number of threads per inch.
3. Head shape.
4. Material of which manufactured.
5. Finish.

The following is a typical example of a machine screw description:

1/2 inch, 8-32 round head, brass, chromium-plated. (8-32 means screw gauge No. 8, 32 threads per inch.)



40. COMMON MACHINE SCREWS

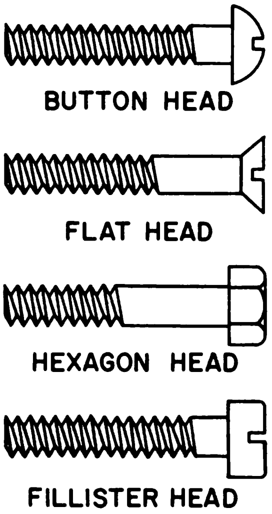
Machine screws are driven, depending on the type of their heads, with screwdrivers or wrenches: Slotted heads are driven with plain screwdrivers, phillips heads with phillips screwdrivers, and hex-heads are turned with socket wrenches.

The most frequently used types of machine screws are shown in illustration at the bottom of the page.

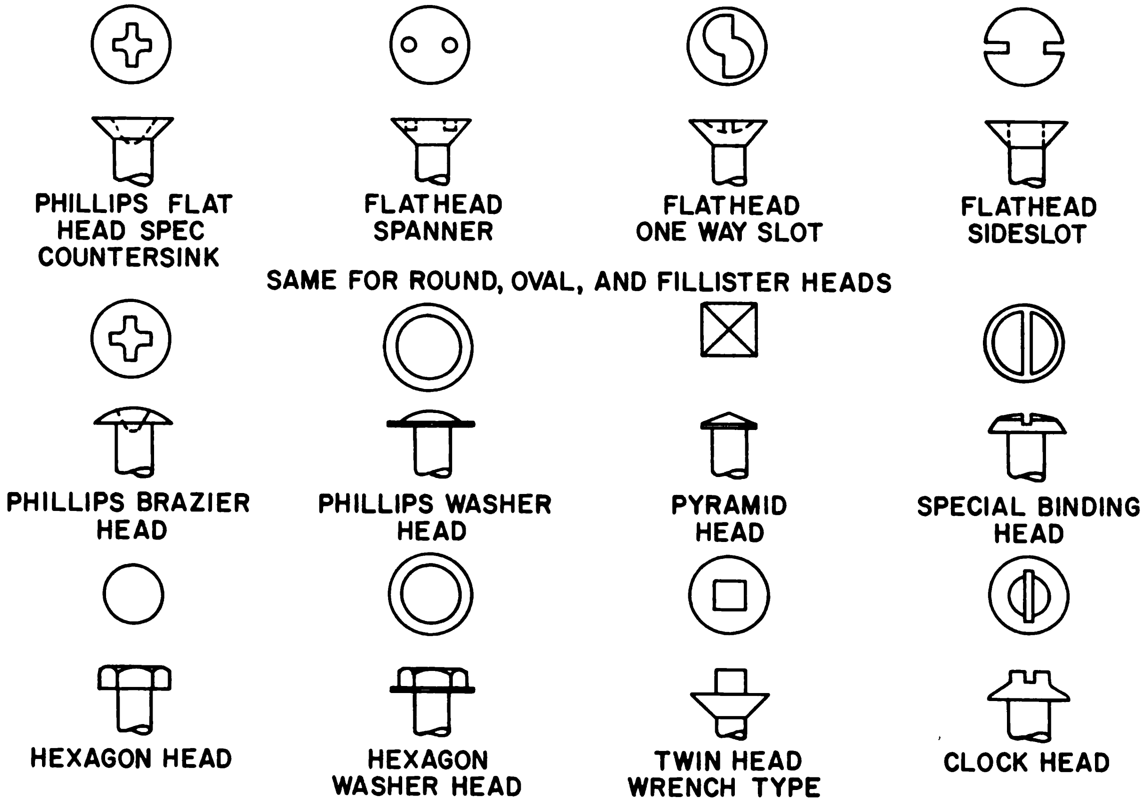
The special type screws, shown in the illustration at the bottom of the page, require special driving tools which are usually included in a kit that comes with the machine or installation for which these screws are intended.

Cap screws may have square, hexagonal, flat, button, or fillister heads. For movable parts, fillister-head screws should be used, because they are sunk into counterbored holes; for fixed parts, hex heads are generally used.

The strongest cap screws are those made of alloy steel; they can withstand stress, strain, and shearing.



42. CAP SCREWS



41. SPECIAL MACHINE SCREWS

Certain special cap screws are made of stainless steel; they are used on machinery exposed to salt water which usually soon corrodes and "freezes" the threads of ordinary steel screws.

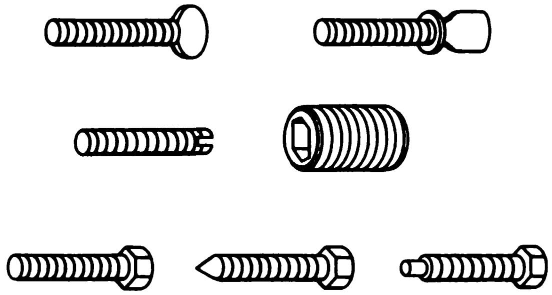
Cap-screw heads may be manufactured with small holes, through which a safety wire is run, to prevent loosening of the screw.

Set screws are used to secure small pulleys, gears, and cams to shafts, and to achieve precise adjustments of machine parts. Set screws are classified according to their diameter, thread, head shape, and point shape.

The classification according to point shape is very important, since the shape of the point indicates the holding characteristics of the set screw. Cone-point or dog-point set screws provide the best holding features, because they fit into the matching recesses in the shafts against which they bear.

Headless set screws (slotted, allen, or bristo-type) are used on movable parts, because these screws are threaded from point to head and do not protrude above the surface.

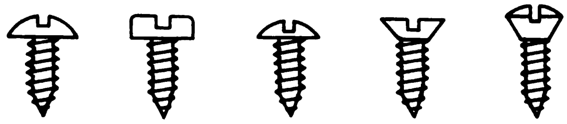
For fixes parts, common set screws with square heads, threaded from the point to the shoulder of the head, are used.



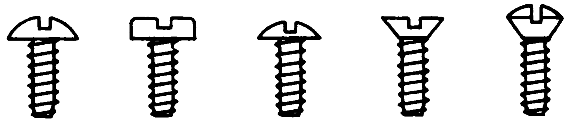
43. SET SCREWS AND THUMB SCREWS

To hold sections of sheet-metal, fiber, plastic, etc., sheet-metal screws are used. These screws are usually classified as type A and type Z.

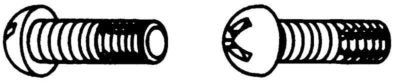
Type A screws have a sharp point and are similar to wood screws, with the exception that the threads of a type A screw extend from the point to the head, while the shank of a wood screw is only partly threaded.



TYPE A SHEET-METAL SCREWS



TYPE Z SHEET-METAL SCREWS



SELF-TAPPING SHEET-METAL SCREWS

44. SHEET METAL SCREWS

Type Z screws have blunt point and the same kind of threads as type A screws.

For heavier metal sheets, self-tapping sheet metal screws are used.

Holes for sheet metal screws are drilled or punched and must be of the minimum diameter of the screw to be used.

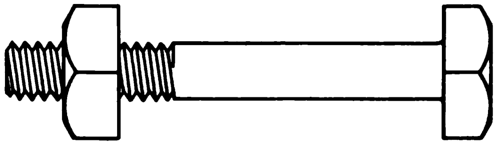
Sheet-metal screws are often called self-tapping screws; this designation is not correct however: A self-tapping screw has a tap-end which actually cuts threads.

Bolts:

Machine bolts are furnished rough, semi-finished, or finished. They are manufactured with a wide variety of diameters, lengths, thread pitches, and head shapes. Diameters of machine bolts range from 3/16 to 3/4 inch, and their lengths from 1/2 inch to 30 inches. (Larger bolts are seldom carried in stock, but can be made on special order.) Most bolts have coarse (NC) threads.

Machine bolts are used to assemble frames and structures of ships, buildings, and bridges. They are also used on temporary structures which have to be easily dismantled.

Certain bolts are manufactured with holes drilled near the end of the threaded part to accommodate cotter keys or safety wires.

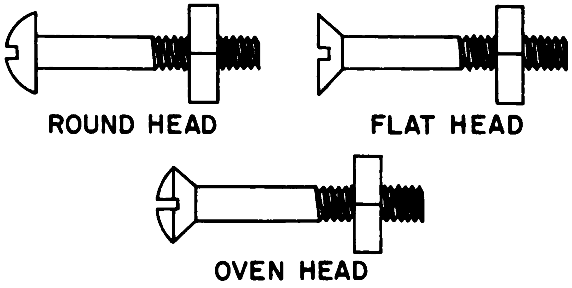


45. MACHINE BOLT

Stove bolts are small and were originally developed (as their name implies) to be used on stoves, but they can also be used on other equipment where no vibration is present to loosen the nuts.

Stove bolts have especially coarse threads which provide a loose (or free) fit for the threads of square nuts.

Stove bolts may have round, flat, or oven heads and either regular or phillips slots.



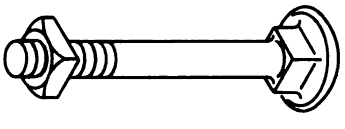
ROUND HEAD

FLAT HEAD

OVEN HEAD

46. STOVE BOLTS

Carriage bolts have brazier (or dunbar-shaped) heads and short square shanks right under their heads. The square shanks prevent the bolts from turning. Carriage bolts are most frequently used on wood, but may also be used on metal.

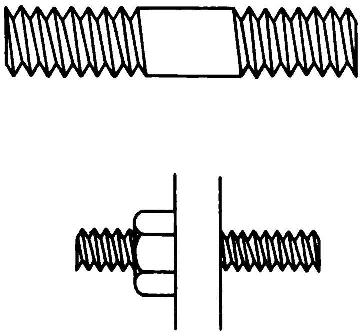


47. CARRIAGE BOLT

Square nuts and flat washers are used with carriage bolts.

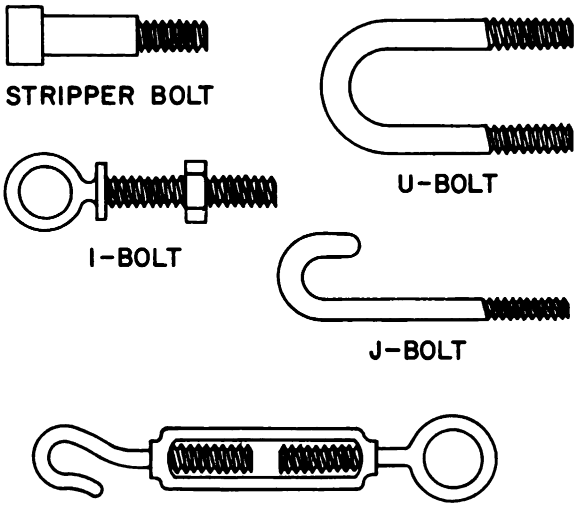
Studs, also called headless bolts, are threaded at both ends: One end is made to be screwed into a tapped hole, the other to accommodate the nut. Studs are used to hold the covers on ordnance equipment, since, to lift the covers, only the nuts have to be taken off, and the studs to not have to be removed.

Studs are used in castings, and therefore they usually have coarse (NC) threads.



48. STUDS

Stripper bolts are used for the same purposes as cap screws. Stripper bolts have a precision-ground and polished shoulder



STRIPPER BOLT

U-BOLT

I-BOLT

J-BOLT

TURNBUCKLE

49. SPECIAL FASTENERS

between the head and the threaded part. This shoulder is used as shaft for gears or cams and as fulcrum for levers.

Stripper bolts have standard fine (NF) threads. The heads of stripper bolts may be hexagonal or fillister, with allen or bristo-type slots.

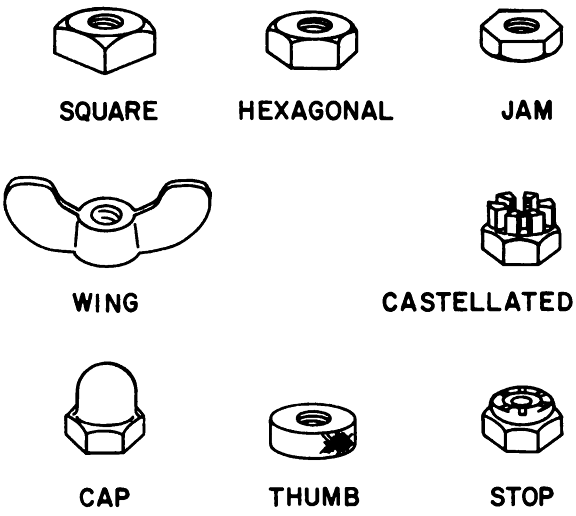
Numerous other types of fasteners have been developed to be used on equipment where regular fastening devices did not prove to be satisfactory. (Refer to illustration on the previous page and note that I (eye)-, J-, and U-bolts which are actually draw-bolts and rather typical examples of special fasteners.)

Nuts:

Square or hexagonal nuts may be supplemented by special nuts, for instance jam nuts, which are used over standard hex nuts to lock the hex nust in proper position. The jam nuts are about half as thick as the standard hex nuts and have washer faces.

A castellated nut is slotted for insertion of a cotter key through its slots and a hole in the bolt, to prevent the nut from loosening.

Wing nuts are used for equipment which requires frequent adjustment.



50. TYPES OF NUTS

Where appearance is an important feature, cap or acorn nuts are used. The cap and acorn nuts are usually made of chromium-plated brass.

Thumb nuts are knurled and can be turned by hand to ease assembly and disassembly.

Elastic stop nuts are used on equipment which requires positive securing of the nuts. These nuts have built-in fiber or composition washers that are automatically pressed against the screw threads, to provide the tension necessary for holding the nuts.

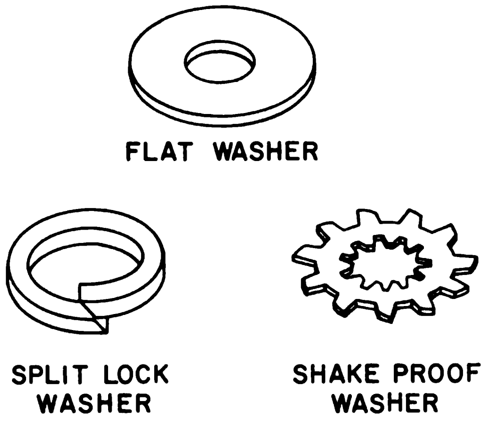
Washers:

Washers are manufactured in many sizes and shapes. Basically, however, they can be divided in two types: common flat washers and lock washers.

Common flat washers are used to back up bolt heads and nuts and to provide larger bearing surfaces. They also prevent damage to the metal surfaces through which the bolts pass.

Split lock washers are spring-hardened, to prevent loosening of the nuts due to vibration. One end of a split washer cuts into the nut, while the other end holds the material to prevent slippage.

Shakeproof lock washers may be obtained in several patented designs, shapes, and



51. TYPES OF WASHERS

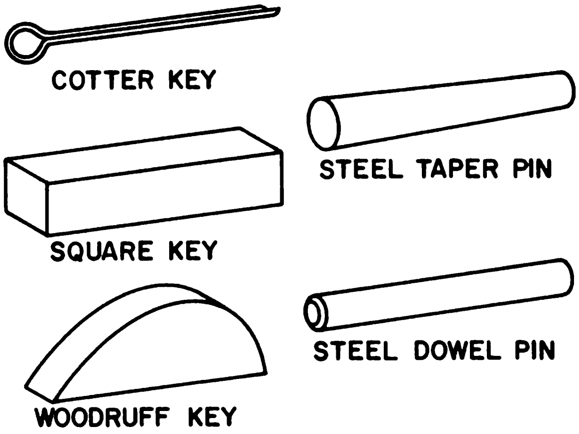
sizes. They have teeth or lugs to hold the material and the nut.

Star lock washers are similar in appearance to shakeproof washers. Star lock washers may be knurled to fit the shaft or may be equipped with one inner lug which fits into a keyway of a shaft. When the washer is installed, at least one of its outer lugs is bent to fit into the recesses on the flat side of a nut, to lock the nut in proper position.

Keys and Pins:

Cotter keys are used to secure castellated nuts to bolts or rods and are also used as stops and holders on shafts or rods.

Square keys and woodruff keys are used to hold handwheels, gears, cams, and pulleys on shafts and arbors. These keys fit into keyways and, when properly fitted and seated, enable the equipment to carry heavy loads.



52. KEYS AND PINS

Taper pins are used to locate the exact position of matching parts and to secure small pulleys and gears to shafts. They usually are equipped with a taper of 1/4 inch per foot. For proper fitting, the holes for taper pins must be reamed with tapered reamers.

Dowel pins are used to position and to aline whole units or separate parts of an assembly. The pins are used where frequent assembly and disassembly is required. One end of a dowel pin is chamfered and is usually 0.001 to 0.002 inch wider in diameter than the specified size, allowing the hole for the pin to be reamed to insure a closer fit.

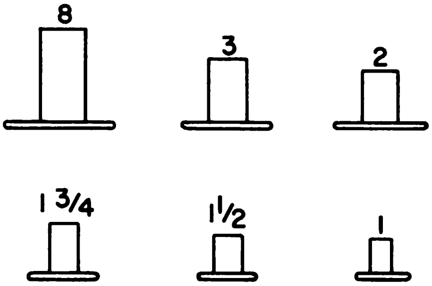
Rivets and Rivet Sets:

Rivets are permanent fasteners which cannot be reused. The holes for rivets are drilled or punched.

Rivets may be carefully spaced and alined. The diameter and length of a rivet to be used must be determined according to the construction features of the material to be riveted.

On thin sheet metal, tinner rivets are used. They have flat heads, are made of soft iron or of steel, and are usually tin-coated to prevent corrosion.

Rivet sizes are classified by numbers according to the weight of 1,000 rivets. For instance, rivets of which 1,000 weigh 1 pound are classified #1, of which 1,000 weigh 2 pounds, #2, etc. The most frequently used are 1-pound and 2-pound rivets. They are usually sold in 1-pound packages or boxes.

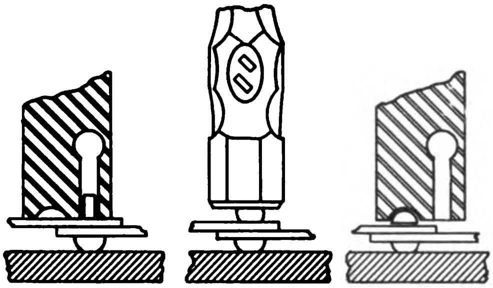


53. TINNER'S RIVETS

All rivets of one size are identical. The length of each rivet is in proportion to its weight and diameter.

Rivet sets are available in several sizes. They are used for pulling the rivet heads tightly against the metal sheets and for pressing together the sheets to be riveted.

After a rivet is upset (headed on its headless end) with a riveting hammer, the rivet set is used to round up the upset end.



54. USE OF RIVET SET

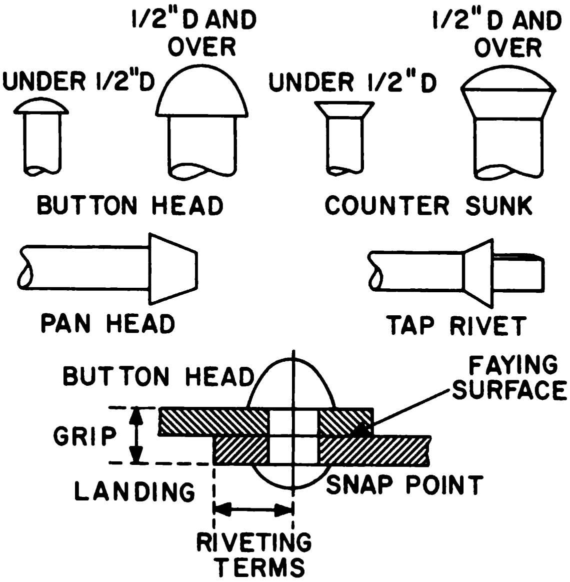
Where appearance is a main concern, small round-head rivets made of iron, brass, aluminum, or copper are used, since the appearance of the headless end of a round-head rivet can be improved by using a rivet set of the proper size.

Structural rivets are used on all types of steel frames and structures, to fasten plates and other parts of a ship. Structural rivets are usually heated before they are driven into the material; when they cool off, they contract and hold the riveted parts tighter together. Heated rivets are also easier to drive.

The diameters of structural rivets usually vary from 1/4 inch to 1-1/4 inches, but for thicker material, larger rivets have to be used.

The distance from the center of a rivet to the edge of a sheet should never be less than 1-1/2 times the diameter of the rivet. The space between rivets should be from 3 to 8 times the diameter of the rivet, measured from the center of one rivet to the center of another.

A rivet may be removed by cutting off its head with a cold chisel and punching out the body of the rivet. To ease removal of a small rivet, a hole can be drilled through its head (the hole should be drilled through the head only), and the weakened head can be cut off with a cold chisel.



55. STRUCTURAL RIVETS

QUIZ SHEETS:

1. On electric equipment, tools with ________________handles should be used.

2. When tools have to be sharpened on power grinders, the most important safety precaution to be taken is the use of

   a. Gloves.
   b. Goggles
   c. Insulated handles.
   d. Safety shoes.

3. Which type of pliers is suited best for cutting and removing cotter pins?

   ____

   ____

4. Holes in metal are started with a/an

   a. Starting punch.
   b. Pin punch.
   c. Center punch.
   d. Alining punch.

5. Which type of metal is used to make the strongest wrenches?

   ____

   ____

6. Which instrument or tool must be used in conjunction with calipers, to obtain accurate measurements?

   ____

   ____

7. One complete revolution of the thimble on a micrometer equals____________ inch(es).

8. Micrometers may be adjusted to compensate for wear.

   True__________or False________.

9. The teeth of a hacksaw blade should be pointed

   a. Toward the handle.
   b. Away from the handle.

10. Pressure should always be applied to the hacksaw during the back stroke.

    True__________or False________.

11. Files are designed to cut only on the forward stroke.

    True__________or False________.

12. The angle from the centerline of a twist drill to the cutting lip should be

    a. 59°.
    b. 12°.
    c. 15°.
    d. 45°.

13. Of which kind of material must twist drills be made for drilling armor plate?

    a. Carbon steel.
    b. Alloy steel.
    c. Stainless steel.
    d. Chromed steel.

14. Reamers are used to smooth and to enlarge holes to the exact size required.

    True__________or False________.

15. Taps are used for cutting external threads.

    True__________or False________.

16. Soft solder is composed of:

    a. 50% zinc and 50% tin.
    b. 50% copper and 50% lead.
    c. 50% lead and 50% zinc.
    d. 50% tin and 50% lead.

17. Electrical connections should be soldered by using a flux composed of:

    a. Acid.
    b. Zinc chloride.
    c. Rosin.
    d. Stearine.

18. The process of coating a copper soldering iron with solder, to prevent oxidation of the iron when it is heated, is called:

    a. Fluxing.
    b. Tinning.
    c. Oxidizing.
    d. Acid treatment.

19. When installing tubing, always use straight lengths of tubes, where possible.

    True_________or False________.

20. Dowel pins usually have a taper of 1/4" per foot.

    True_________or False________.

21. How many threads per inch has a 6-32 machine-screw?

    a. 6.
    b. 32.
    c. 26.
    d. 38.

22. The points of type Z metal screws are:

    a. Sharp.
    b. Round.
    c. Blunt.
    d. Coned.

23. Carriage bolts have short square shanks under their heads.

    True_________or False________.

Accuracy of notes checked by instructor:

Trainee's initials____________________

Date__________________________

Section 5

POSITIONING MECHANISMS

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Gears and Gear Trains	98
2.	Cams	108
3.	Differentials	112
4.	Linkages and Couplings	114

TOPIC 1: GEARS AND GEAR TRAINS

You Are Now Going to Learn:

1. Definitions, uses, characteristics, and types of gears and gear trains.
2. Operational principles of gear trains.

Discussion Points for this Topic Are:

1. Definitions of gears.
2. Uses of gears and gear trains.
3. Characteristics of gears and gear trains.
4. Types of gears and their uses.
5. Operations of gear trains.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10624, pages 65 through 76.

INFORMATION AND DISCUSSION:

When two or more shafts are not located in the same straight line, but are parallel or perpendicular to each other, motion can be transmitted from one shaft to another by means of gears.

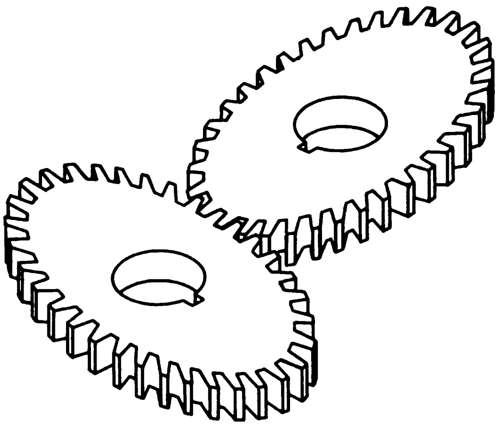
Gears are wheels with teeth cut into their surfaces. The teeth may be either internal or external; their cut or angle may vary.

Gears may have various outlines; usually they are round, but may also be elliptical or eccentric (irregular), as shown in the following illustration.

A combination of two or more gears is called a gear train.

If two meshing gears are of the same size, they also have the same number of teeth. The teeth of the one gear are machined to match the teeth of the other gear, so that one gear can turn the other without slippage. One revolution of the driving gear rotates the driven gear also one revolution, because each tooth of the driving gear pushes a corresponding tooth of the driven gear.

Gears are also used to change the direction of motion; for instance, rotary motion can be changed to straight line or up and down motion.



56. ELLIPTICAL OR ECCENTRIC GEARS

In addition, gears can be used to reduce or increase the rate of motion or torque.

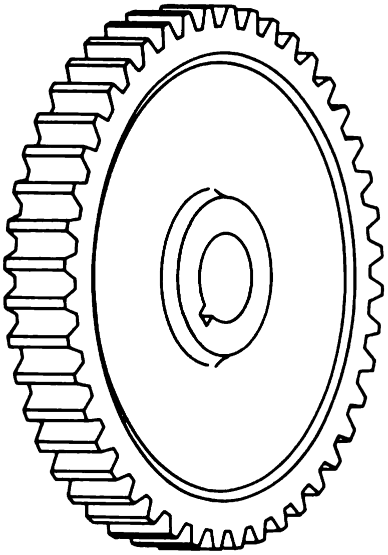
Depending on the purpose, various types of gears can be used, for instance, spur gears, helical gears, or bevel gears.

Gears are generally made of hardened metal; however, if quiet operation at high speed is essential and if the gears are not subjected to severe strain, nonmetallic gears can be used. The latter may be made of formica (a laminated insulating material) or of some other kind of plastic.

Where gears are subjected to friction, a driver gear made of leather or fiber and a driven gear of metal are used. The result is a smooth but not powerful drive.

The most commonly used types of gears are spur gears. They are used to connect parallel shafts. The teeth of spur gears are cut parallel to the axis of gear rotation.

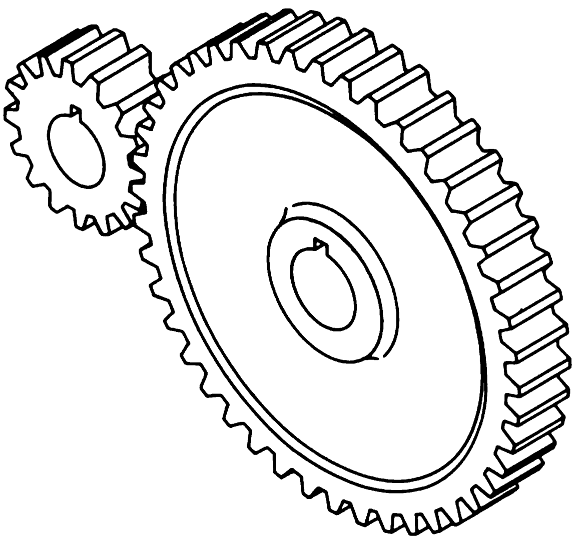
The following illustration shows a spur gear.



57. SPUR GEAR

When two external gears mesh, they rotate in opposite directions. (The most common type of external spur gears is shown in the illustration at the top of adjacent column.)

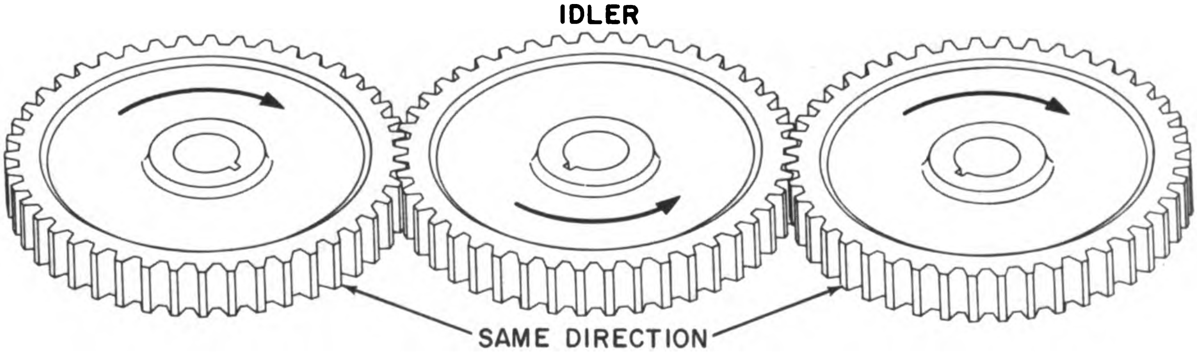
To rotate two spur gears in the same direction, an idler gear is placed between them as shown in the illustration below. The idler gear does not change the gear ratio or speed of rotation; it merely changes the direction of motion. (Both, the driver gear and driven gear, rotate in the same direction.)



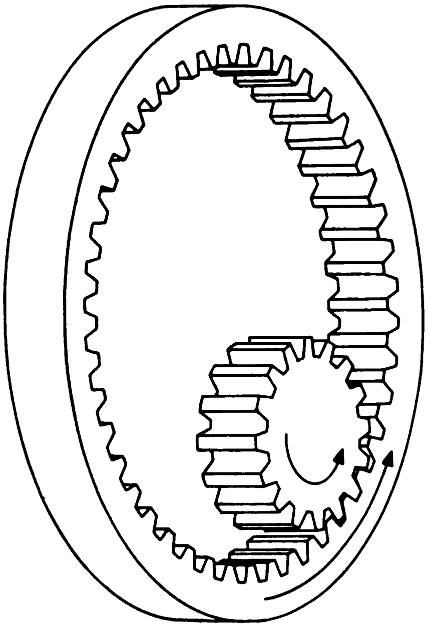
58. EXTERNAL SPUR GEARS

If two gears are different in size, the smaller one is usually called a pinion. When gear and pinion mesh, their shafts rotate at different speeds; for instance, the shaft of the pinion (driver gear) may complete one revolution, while the shaft of the driven gear completes one-half revolution.

The ratio between the number of teeth on the driver gear and the number of teeth on the driven gear is called the gear ratio. The gear ratio can be established by counting the teeth on the gears.



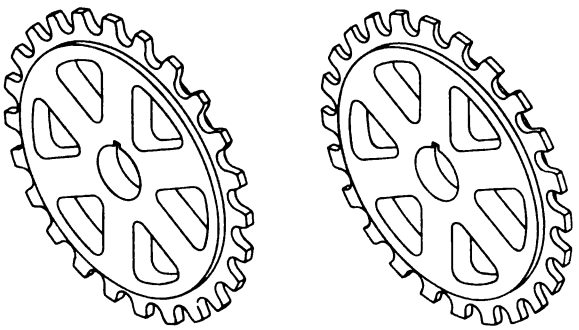
59. IDLER GEAR



60. INTERNAL SPUR GEAR

An internal spur gear has teeth on its inner surface, as shown above. Usually, an internal spur gear is meshed with an external spur gear. The rotation of the pinion causes the driven gear to rotate in the same direction as the pinion rotates.

Sprocket gears are toothed wheels used for driving chains. Sprocket gears have have regular (spur type) or nonreversing (hook type) teeth, as shown in the following illustration. The hook type teeth permit rotation in one direction only.

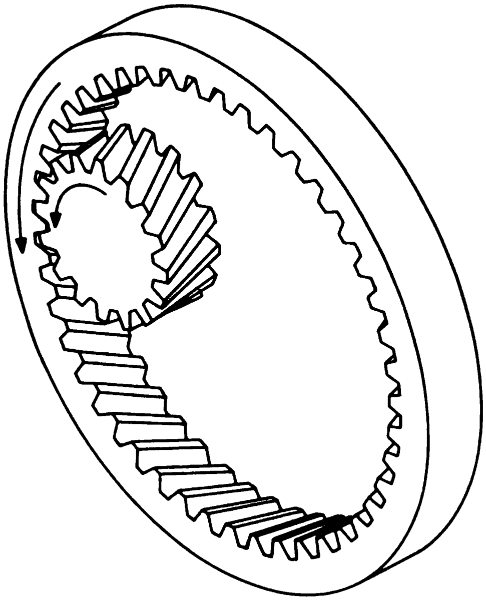


A. REGULAR

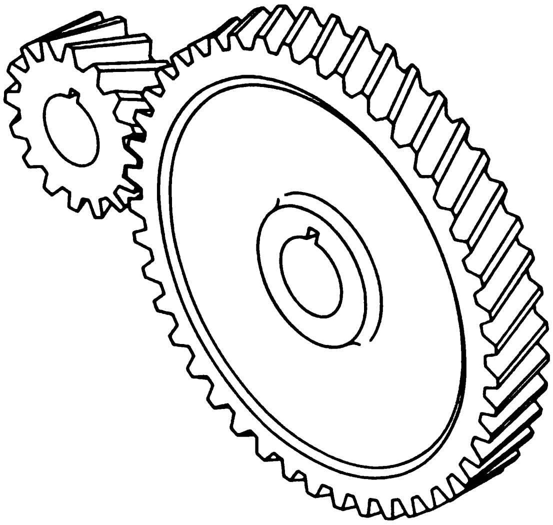
B. NON-REVERSING

61. SPROCKET GEARS

Helical spur gears are used where smooth operation is required. (Helical gears are shown in the following illustration.) The teeth of helical gears are cut at an angle across the face of the wheel and provide a more constant pull than regular spur gears.

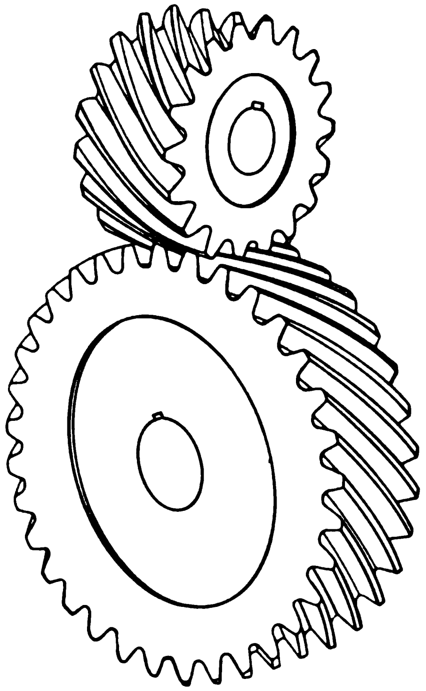


A INTERNAL



B EXTERNAL

62. HELICAL GEARS



63. SPIRAL GEARS

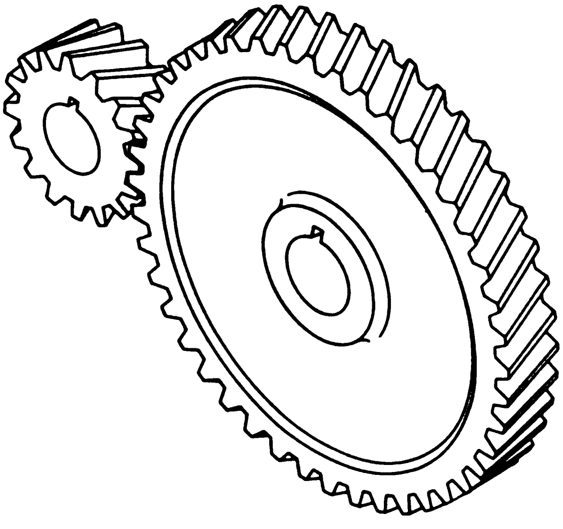
> NOTE: Since the driven gear of spur gears meshes with the two teeth of the driver gear only at certain intervals, the resulting motion is actually a series of sharp jerks.

On helical gears, the curves of the teeth enable the succeeding teeth to start meshing before the preceding teeth are unmeshed.

Helical gears are also called skews or spiral gears, although they actually are not absolutely spiral. (Spiral gears are shown in the illustration above.)

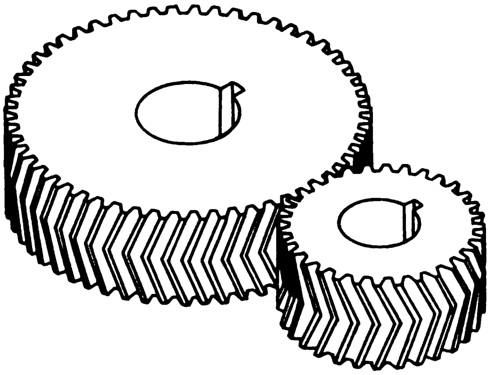
When helical spur gears are used to connect parallel shafts, they may also be called twisted spur gears, as shown in the illustra- at the top of adjacent column.

A negative feature of helical spur gears is the tendency of each gear to thrust (push) axially against its shaft. To counteract this thrust, special thrust bearings must be installed at the end of the shaft.



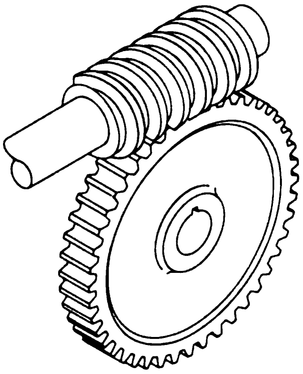
64. TWISTED SPUR GEARS

To eliminate the thrust, double helical herringbone gears can be used. They are similar to right-hand and left-hand helical gears placed side by side as shown by the following illustration. The teeth of these two gears meet in a chevron like pattern. The right-hand gear teeth counterbalance the thrust of the left-hand gear teeth or vice versa. As a result, the thrust is eliminated.

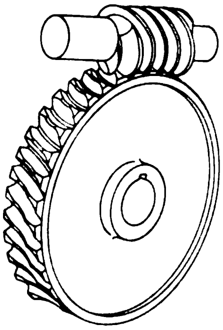


65. HERRINGBONE GEARS

Herringbone gears are used on parallel shafts of heavy machinery, for instance, turbines.



A SPUR-TYPE TEETH



B HELICAL TYPE TEETH

66. WORM GEARS

Worm gears are used to transmit motion between shafts which are located at right angles to each other. The worm gears may have spur type or helical type teeth, see the illustration above.

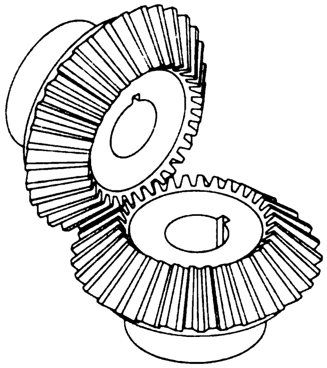
The worm consists of a cylinder with one (single) thread or more (double, triple, etc.) threads which are cut on its outside like the threads of a screw.

The worm wheel gear has teeth cut on its outside rim. These teeth mesh with the threads on the worm. Worm gears are used to reduce speed.

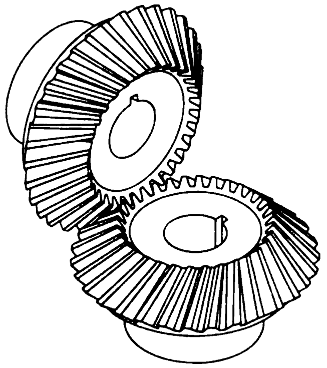
A complete revolution of a single threaded worm rotates the gear a distance of one tooth; a double threaded worm rotates the gear twice as fast as a single threaded worm.

Worm gears are extremely helpful in performing mechanical work; for instance, a small electrical motor which is connected to worm gearing can drive much heavier equipment than it normally could.

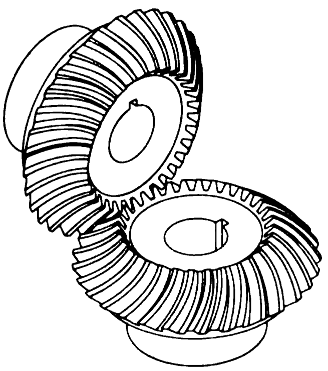
Worm drives are usually constructed so that only the worm is the driver. For example: The worm gear of a deck hoist can raise or lower a load by pulling the chain which



A SPUR-TYPE TEETH

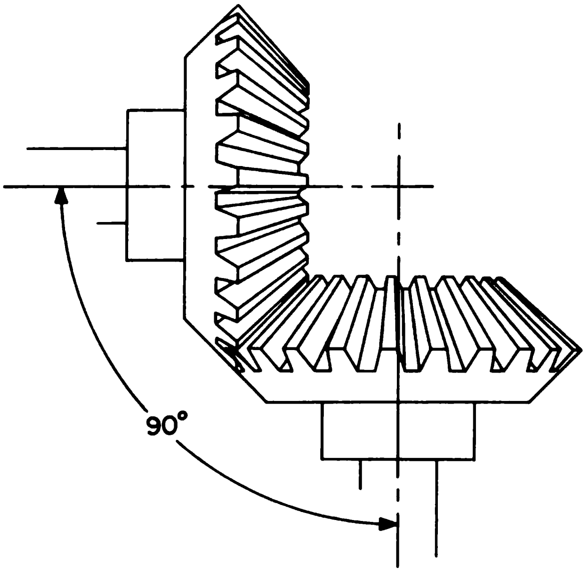


B SKEW-TYPE TEETH



C HELICAL TEETH

67. BEVEL GEARS



68. MITER GEARS (1 : 1 RATIO)

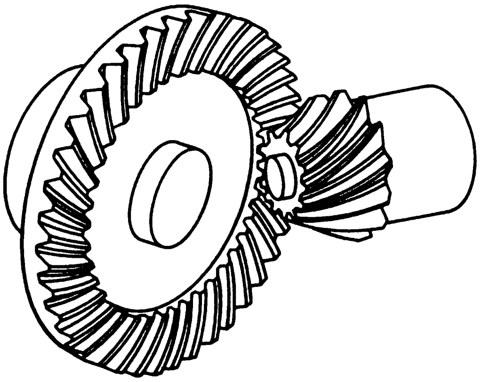
rotates the worm. When the chain is released, the load is prevented from dropping on the deck by a nonreversing worm drive; that is, the weight of the load can not drive the worm.

Bevel gears have teeth cut on conical surfaces. These gears are used for transmitting power between shafts which are located at various angles to each other. The gears may have spur type, skew type, or helical (spiral) teeth, as shown in the preceding illustrations.

Bevel gears which are of the same size (have the same number of teeth) and whose shafts are located at right angles to each other are called miter gears. (The various applications of miter gears will be discussed in Topic 3 of this section.)

A recent development in bevel gearing is the Zeral tooth gears or Gleason bevel gears. The teeth of these gears are curved to provide continuous contact and to avoid concentrated loads on the ends of the teeth in the event of a slight misalinement. The Gleason bevel gears operate quieter than all other bevel gears.

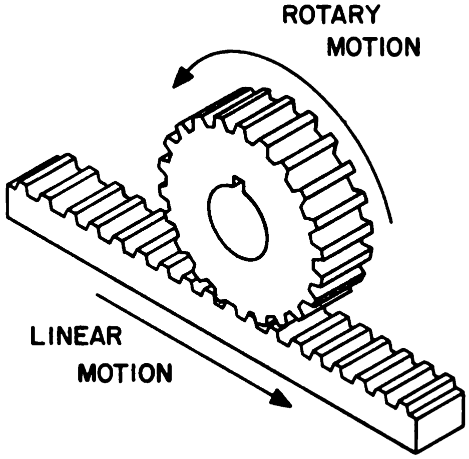
The hypoid gear, illustrated at top of adjacent column, is a spiral bevel gear whose



69. HYPOID GEARS

pinion is located above or below the center of rotation of the gear.

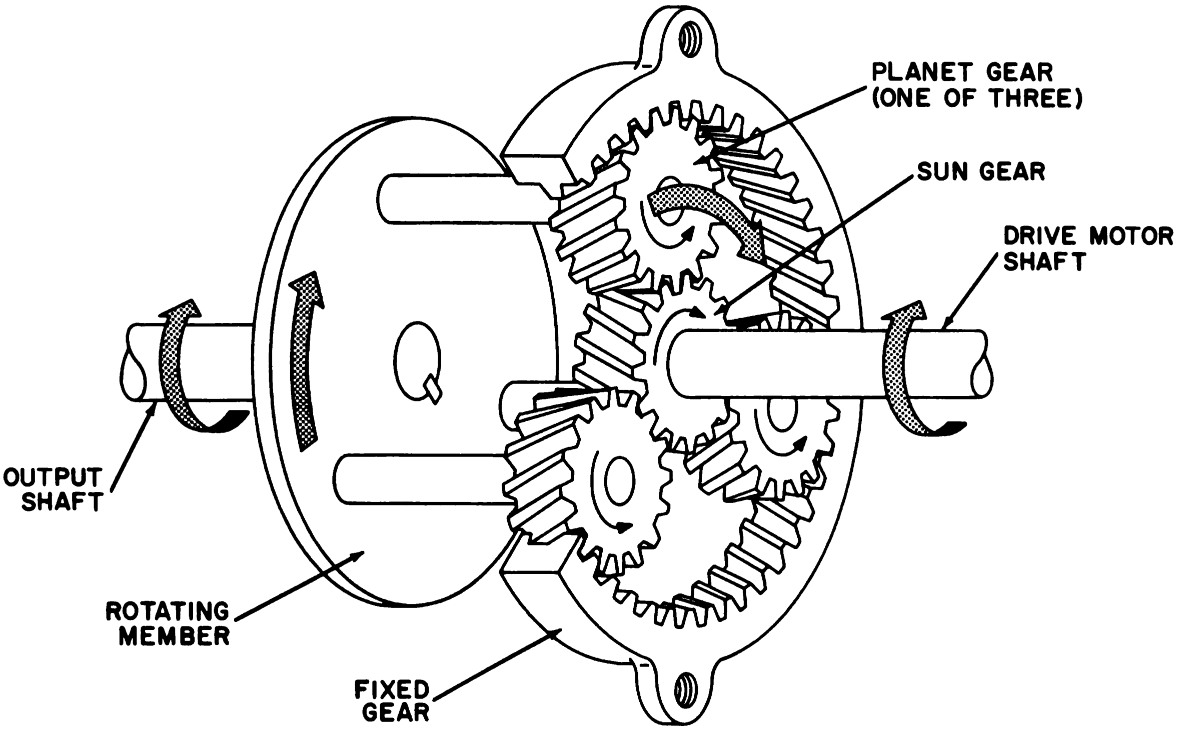
The rack and pinion, illustrated below, are devices for converting rotary motion to linear motion or vice versa. The small wheel (pinion) meshes with a toothed rack. Both, the rack and pinion, have usually spur type teeth.



70. RACK AND PINION

Planetary gears (also called epicyclic gears) consist of a train of gear wheels. The center (helical) gear is called a sun gear.

In planetary gears, three helical gears (called planet gears), grouped 120 degrees



71. PLANETARY GEARS

apart, mesh with the sun gear and a large fixed internal gear, as shown in the illustration above.

When the drive motor shaft revolves, it causes the sun gear, which is an integral part of the shaft, to rotate. This motion is transmitted to the planetary gears which, in turn, transmit the motion to the fixed internal gears, producing an output at reduced speed on the output shaft.

The planetary reduction gears are used to reduce the speed of drive motors in hydraulic train and elevation systems. For example, the electric drive motor of a 5"/38 twin mount revolves at approximately 3500 rpm, while the hydraulic pump is designed to rotate only at 900 rpm; therefore, a planetary gear, located between the electric motor and the pump, is used to reduce the speed of the pump to 900 rpm.

Planetary gears are also used in other systems for similar purposes.

To define the diameter of a gear, it is necessary to specify whether it is an outside diameter, a bore diameter (diameter of hole in gear), root diameter (root to root diameter of of opposite teeth), or a pitch diameter.

The pitch circle is a line drawn through the pitch point of each gear tooth that represents an imaginary surface which corresponds to the friction surface. The pitch diameter is the diameter of this circle.

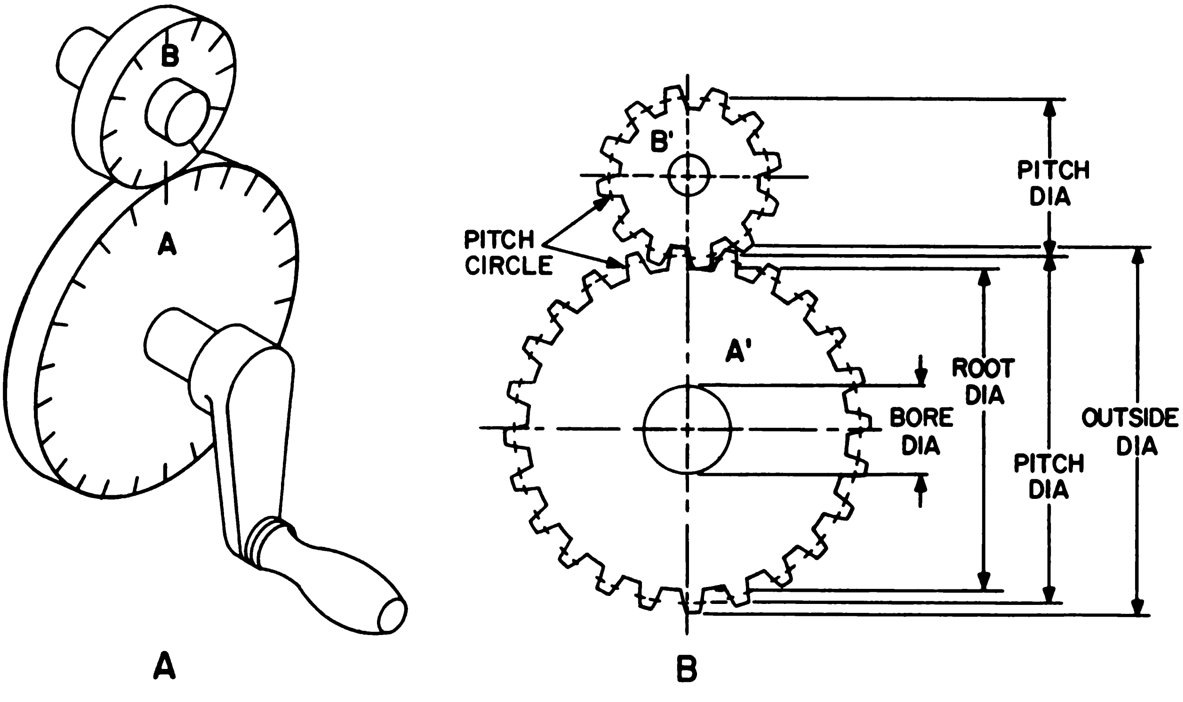
In gearing, the pitch diameter is a very important factor, because the relative velocities of the meshing gears depend upon their pitch diameters. (The number of teeth in the pitch circle determines the speed of a gear.)

The part of the tooth located between the outside circle and the pitch circle does not transfer any power; the transfer begins at the pitch point of a gear tooth.

The term pitch is used in machinery to denote the distance from one pitch point of a gear tooth to the corresponding pitch point of the next tooth, as illustrated below. If a gear is defined as a 20-DP or 20-P gear, it has 20 teeth on each inch of its pitch diameter. The letters DP stand for diametrical pitch. They also define the size of the gear teeth. For instance, if a gear with a pitch diameter of 2 inches has 40 teeth, it has 20 teeth per inch of pitch diameter or 20 DP. A gear of the same pitch diameter (2 inches) with a total of 20 teeth would be defined as a 10-DP gear. The teeth of the 10-DP gear would, of course, be larger and heavier than those of the 20-DP gear. (Two meshing gears must have the same diametrical pitch.)

NOTE: When internal and idler gears are used, the driver and driven gears always move in the same direction. To reverse direction, two external gears are used. Bevel or spiral gears are used when gear shafts are located at angles to each other. Various combinations can be acquired through gear trains.

As already mentioned at the beginning of this topic, gears are also used to change the speed of motion. For instance, if a 24-tooth gear is meshed with a 12-tooth gear (pinion), the 24-tooth (driver gear) makes one revolution, while the 12-tooth gear (driven gear) makes two, thus producing a speed increase at a 1 : 2 ratio. If the 12-tooth gear is the driver, the ratio is reversed and the speed reduced; but there is a gain in force, since the input gear makes two revolutions while

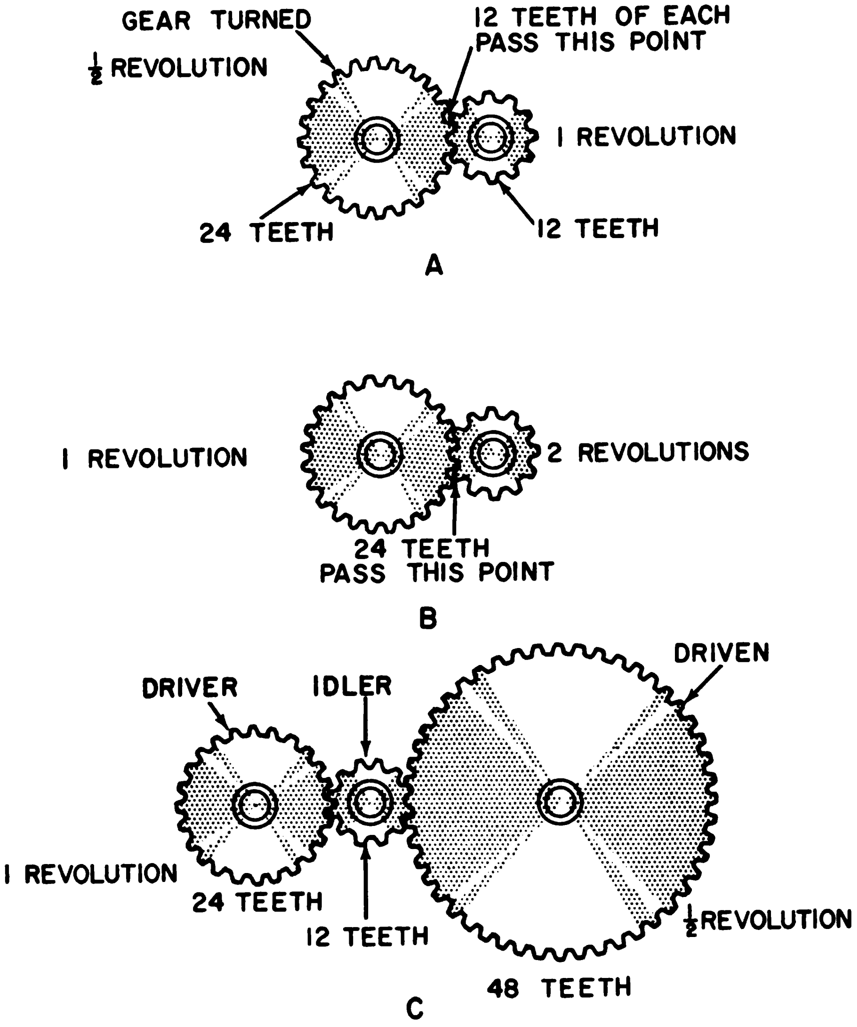


72. PITCH MEASUREMENTS OF GEARS

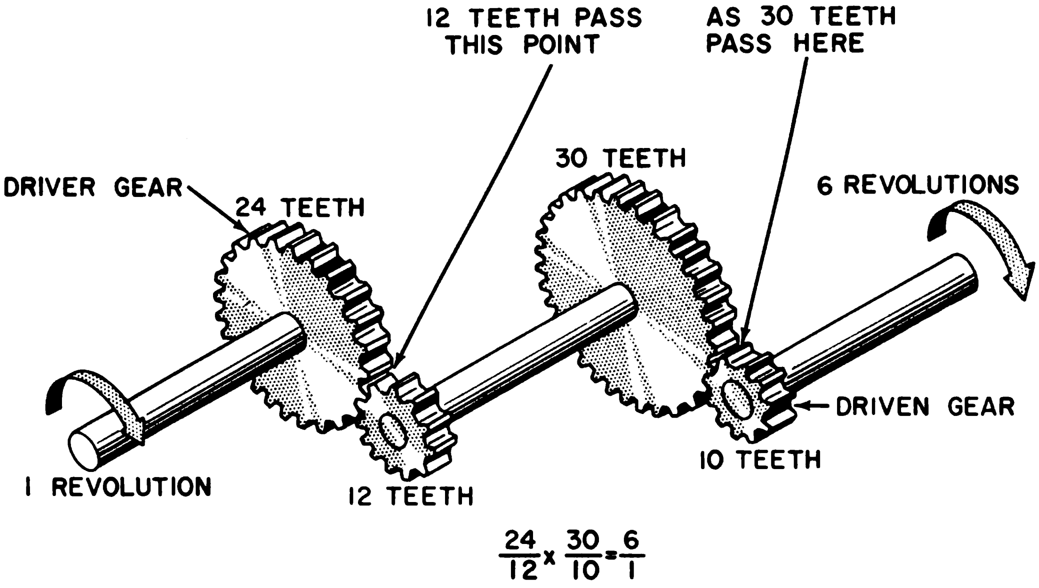
the output gear makes one, as shown in the illustration at the bottom of this page.

When an idler gear is placed between the driver gear and the driven gear, the gear ratio of the driven gear shown in the illustration can be found by using the following formula:

$$24/12 \times 12/48 = 1/2$$



73. GEAR RATIOS



74. STEP-UP GEAR TRAIN

However, to step up six times the speed of an output shaft which has a 10-tooth gear, a driver gear with 60 teeth would be required which would be rather complicated; therefore, a gear train is used to achieve the same result in an easier way as shown in the illustration above.

The 24-tooth gear meshes with the 12-tooth gear and causes it to rotate twice as fast as the input gear. The 12-tooth gear, in turn, rotates the 30-tooth gear at the same speed. The 30-tooth gear is meshed with a 10-tooth gear. The 30-tooth gear is now the driver and causes the 10-tooth gear to rotate at three times the speed of the driven gear.

The resultant ratio is:

$$24/12 \times 30/10 = 6/1$$

TOPIC 2: CAMS

You Are Now Going to Learn:

1. Purpose, construction features, and classification of cams.
2. Application of cams in ordnance equipment.

Discussion Points for this Topic Are:

1. Purpose of cams.
2. Classification of cams.
3. Construction features of various types of cams.
4. Special cams.
5. Application of cams in ordnance equipment.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10185, pages 64 through 68.

INFORMATION AND DISCUSSION:

Cams are mechanisms that normally contain a curved path or surface (either groove, ridge, or contour) and are used to convert rotary motion to linear motion.

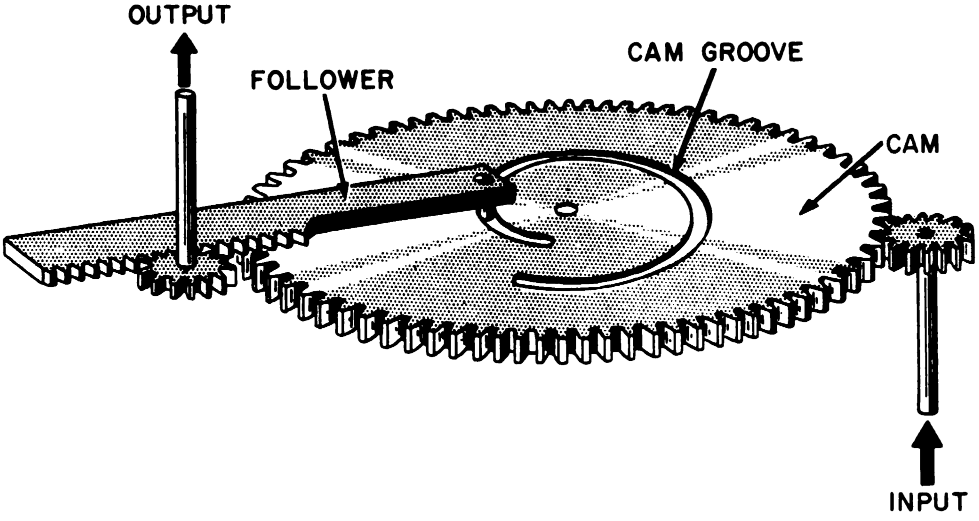
All cams have a follower (a roller, ball, or pin) which bears against the curved surface or follows the path of the cam. As the cam rotates, the follower is pushed or pulled by the curved surface or path in a position which represents the output value for the contact point of the cam.

Cams are not ordinarily used for transmitting power as, for instance, gear trains are; normally cams are used to modify mechanical movements, to control other mechanisms, or to synchronize engaging units.

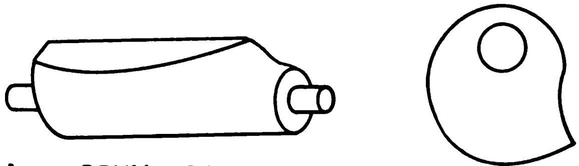
A cam can be a simple device used to trip a switch or can be a complicated mechanism capable of computing the tangent, square, or reciprocal of the input.

In the illustration below, a rack and pinion are shown which are used to convert the linear cam output to a rotary motion. However, not all cams are like the one shown in this illustration: Some cams are just a projection of a shaft or a wheel; others do not move, but are contacted by a mechanical lever, arm, or actuator.

Technical manuals disagree on how to classify the various types of cams, since they may either be grouped by their functions or by shapes. In the illustration

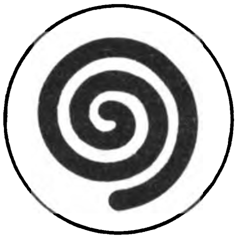


75. TYPICAL CAM WITH ASSOCIATED LINKAGE



A. DRUM OR BARREL CAM

B. EDGE CAM



C. FACE CAM

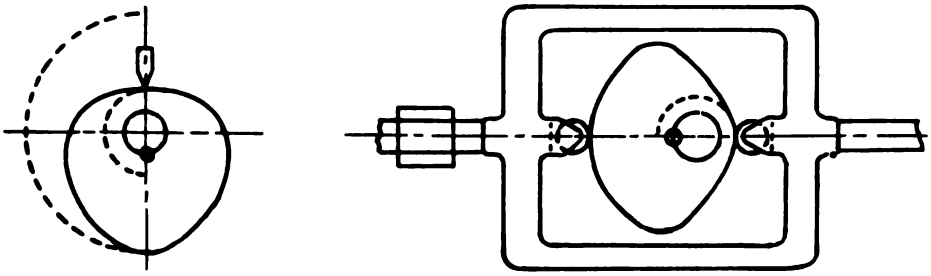
76. CLASSIFICATION OF CAMS BY SHAPE

shown above, the cams are classified by shape.

The drum (barrel) cam shown in that illustration requires two inputs: One to rotate the cam (barrel), the other to move the follower laterally. The output of this cam is in a plane perpendicular to the axis of the cam. The drum cam is also called a three dimensional or ballistic cam. It is used mainly in fire control equipment.

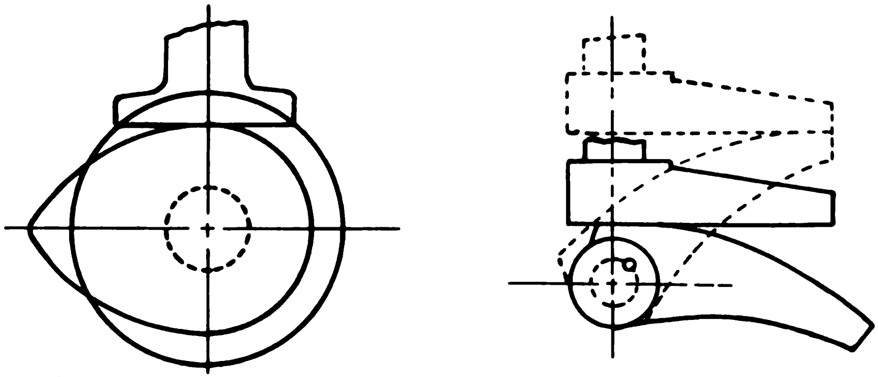
There is another type of drum (barrel) cam which has a path for the roller (or follower) cut around its contour. The output of this cam is parallel to the axis of the cam. This type of cam requires only one input.

The edge cam shown in the illustration is the most common type of cam. The edge cam is available in various shapes and sizes. The follower of this cam maintains contact with the outer edge of the cam by force of gravity or by spring action. When the cam is rotated, the follower moves either laterally toward or away from the axis of cam rotation. (Illustration below shows various types of edge cams.)



A HEART CAM

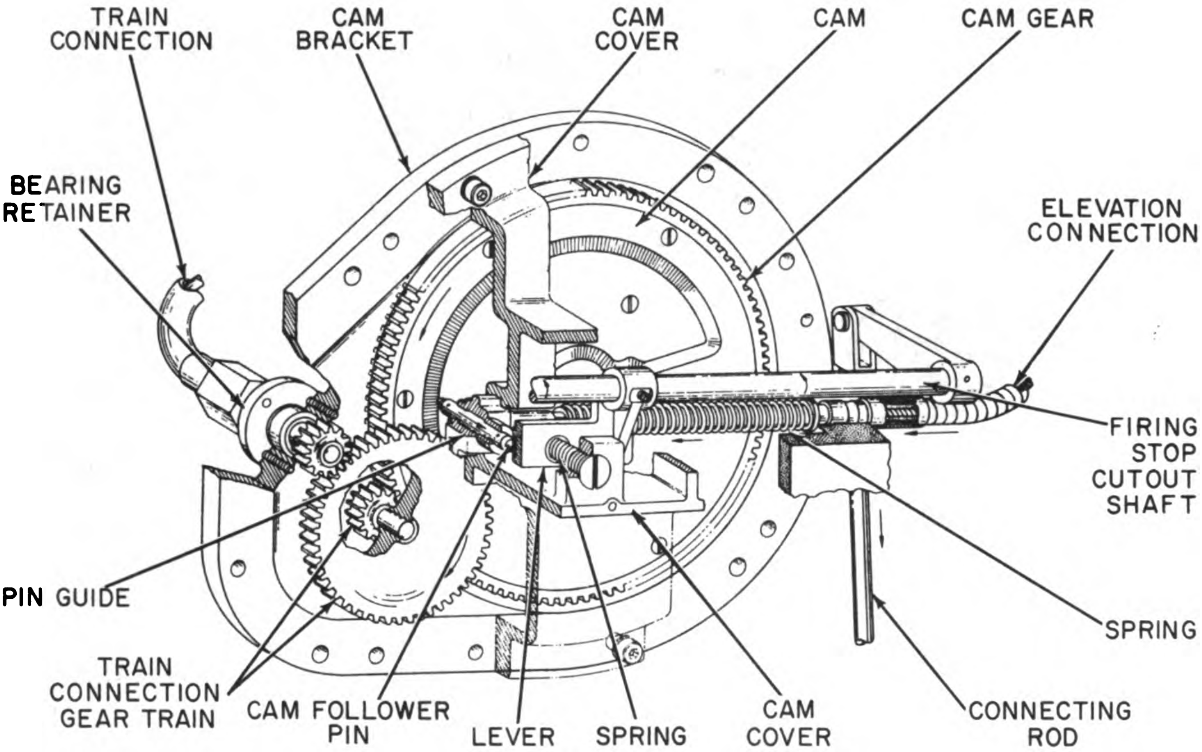
B YOKE CAM



C MUSHROOM CAM

D TOE AND WIPER CAM

77. TYPES OF EDGE CAMS



78. PROFILE FACE CAM

A face cam may have a groove or roll path cut into its face. When the cam rotates, the groove forces the follower either away from or toward the center of the cam.

The spiral groove face cams have frequently run-out sections at each end of cam movement. The run-out section has a constant radius; therefore when the follower is in this cam section, there is no output.

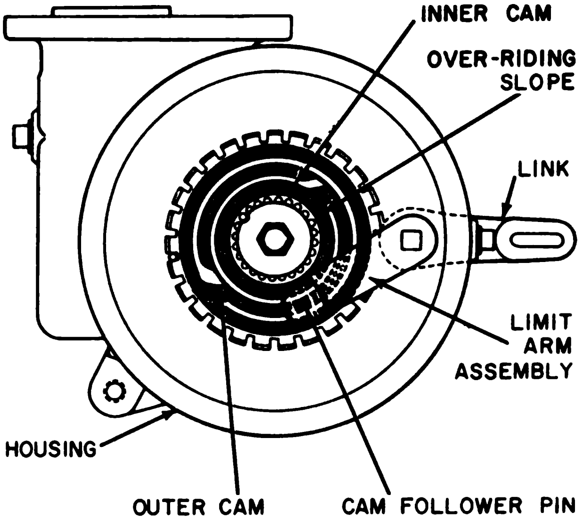
The plate (profile) cam, which is another type of face cam, has a section of the cam face out away, leaving high and low areas. This type of cam usually has two inputs: one for positioning the cam, the other for positioning the follower. When the follower rides from a high to a low section of the cam or vice versa, the follower actuates the output linkage and/or a switch to register the output.

In ordnance equipment, many special types of cams are used to accelerate, decelerate, time, and stop the power devices. The special cams are also physically contacted by the moving power equipment to actuate the mechanical linkages, switches, and valves. The majority of these special cams can be classified as drum, edge, or face cams.

Cams find application in all naval guns, launchers, and projectors. They are used to prevent own ship weapons from firing into own ship structure. In many guns profile face cams are used for this purpose. A profile (plate) face cam and its associated linkage used in the 40 MM firing stop mechanism is illustrated above.

> NOTE: In the 3"/70 gun mounts and missile launcher, a different type of cam is used to perform the same functions. Firing stop mechanisms are also called cutout and firing interrupter mechanisms.

Plate cams with spiral grooves are used on 40 MM guns, Mk 15 projectors, and Mk 108 rocket launchers, to prevent them during power operation from training through a positive stop.



79. POWER DRIVE LIMIT STOP CAM

Edge cams are used in all guns and missile launching systems. For instance, in breech mechanisms of 5"/38, 3"/50, and 40 MM guns, edge cams are used to open the breech after firing; in typical missile launcher power drives, approximately ten edge cams are used to actuate the switches.

TOPIC 3: DIFFERENTIALS

You Are Now Going to Learn:

1. The definitions, types, and uses of mechanical differentials.
2. The operational characteristics of mechanical differentials.

Discussion Points for this Topic Are:

1. Refer to NAVPERS 92662, Vol. 1, Section 1, Topic 24, for discussion points 1 through 8.

ASSIGNMENT:

A. Reference publication:

    1. Study NAVPERS 92662, Vol. 1, Section 1, Topic 24.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 4: LINKAGES AND COUPLINGS

You Are Now Going to Learn:

1. Purpose and types of linkages and couplings.
2. Application of linkages and couplings in ordnance equipment.

Discussion Points for this Topic Are:

1. Basic parts, purpose, and adjustments of linkages.
2. Types and uses of couplings and universal joints.
3. Review and summary.
4. Section review.
5. Written test.

ASSIGNMENT:

A. Reference publication:

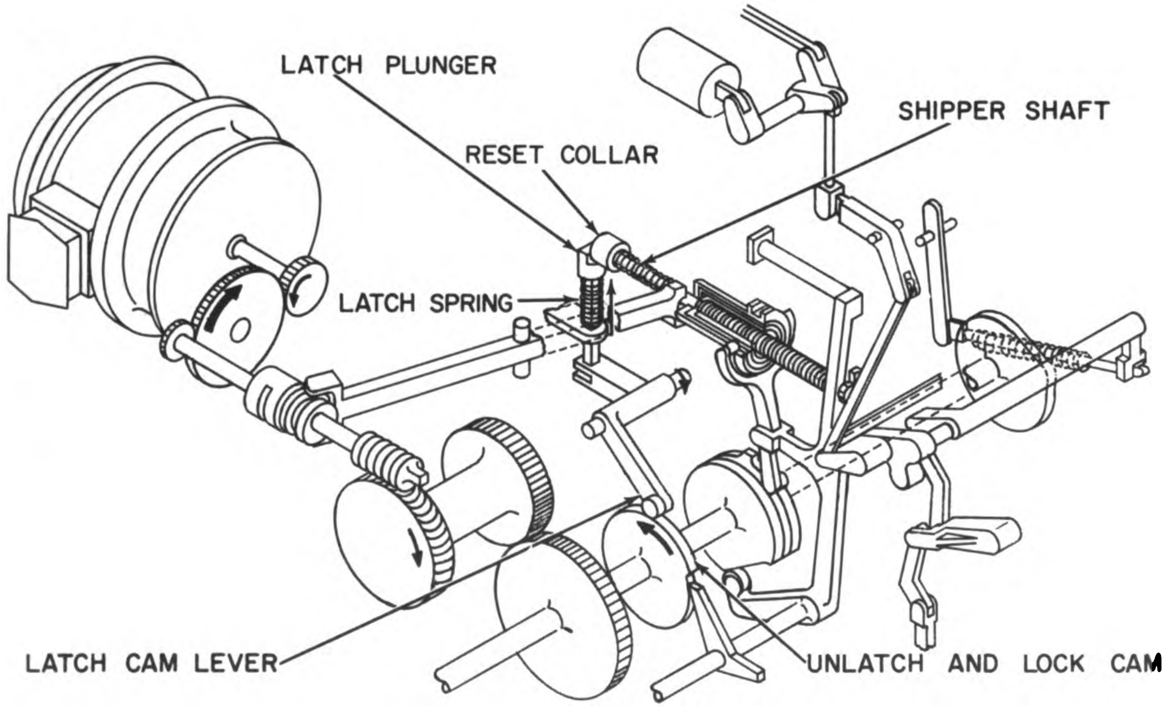
   1. Study NAVPERS 10185, pages 66 through 68.

INFORMATION AND DISCUSSION:

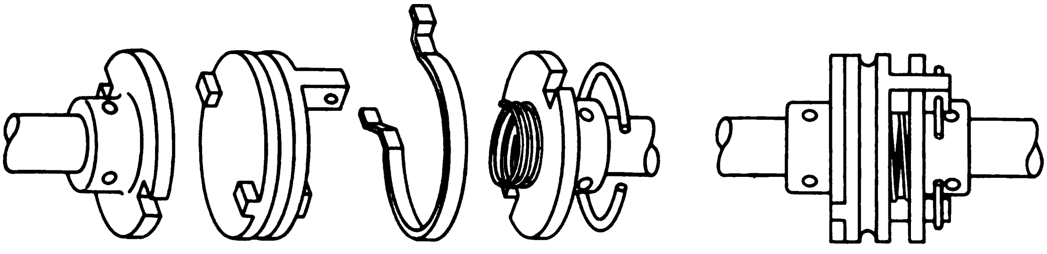
A linkage may consist of one or a combination of basic parts: rod, shaft, or plunger, lever, rocker arm, and/or bell crank. These parts combined are used to transmit limited rotary or linear motion. To change the direction of motion, cams or gears may be used wi with the linkage. In a unit of ordnance equipment, linkage may be used for several purposes. (Refer to the illustration below.)

Lever type linkages are used in equipment which has to be opened and closed; for instance, valves in electric-hydraulic systems, gates, clutches, clutch solenoid interlocks, etc.

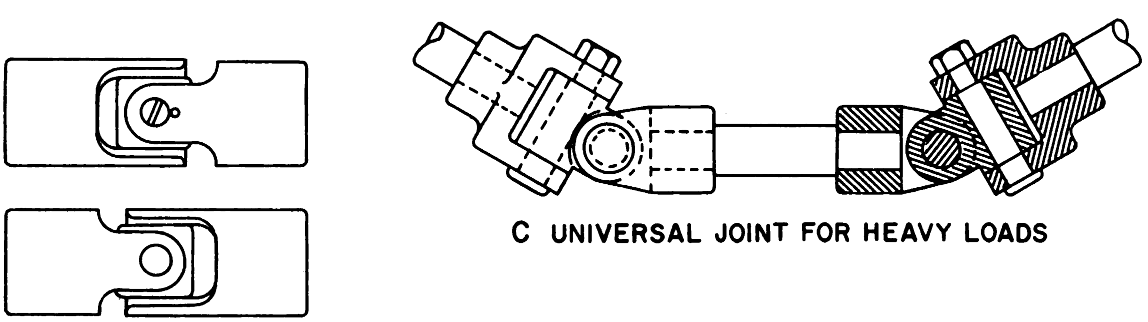
All linkages require occasional adjustments or repair, particularly when they become worn. To make the proper adjustments, a person must be familiar with the basic parts which constitute a linkage. Adjustments are normally made by lengthening or shortening the rods and shafts by means of a clevis or turnbuckle.



80. LINKAGES

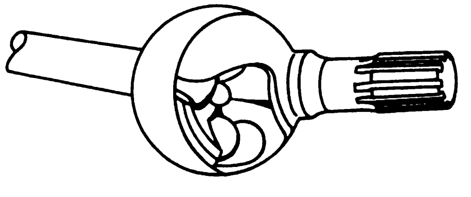


A OLDHAM FLEXIBLE COUPLING

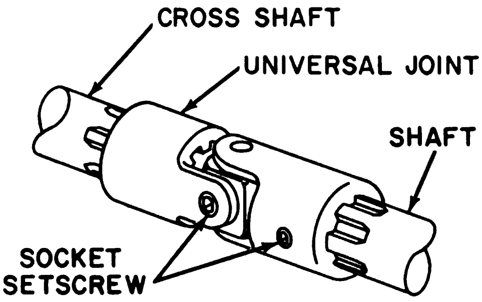


C UNIVERSAL JOINT FOR HEAVY LOADS

B HOOKE JOINT



D BENDIX-WEISS UNIVERSAL JOINT



E UNIVERSAL JOINT ON FIRING FOOT PEDAL

81. TYPES OF UNIVERSAL JOINTS

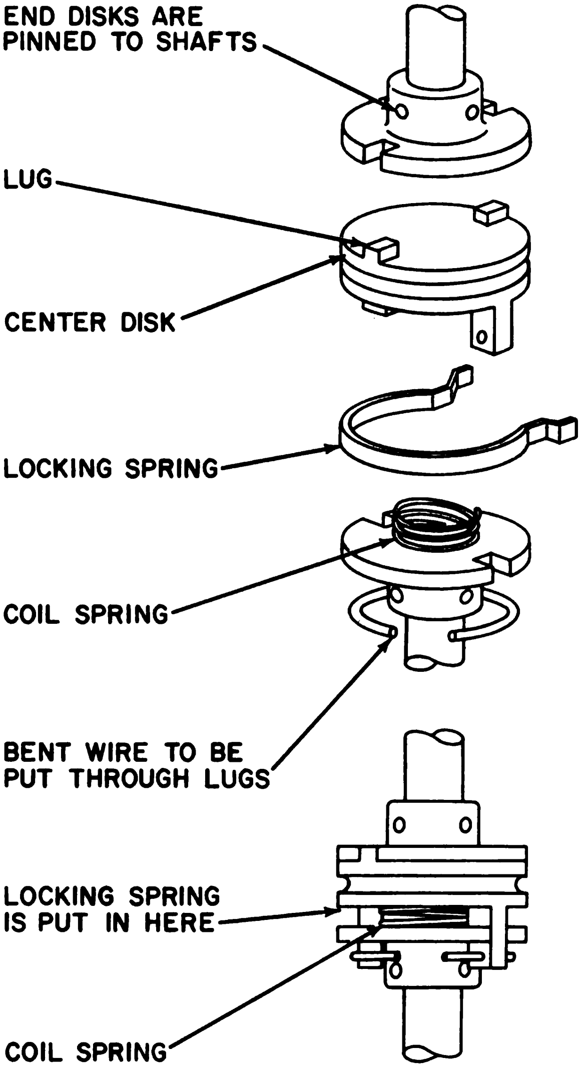
The term coupling (in a broad sense) applies to any device that holds two parts together. Line shafts which are made up of several shafts or different lengths may be held together by shaft couplings of several types.

A universal joint is a coupling between two nonparallel intersecting shafts, which transmits the rotation of one shaft to the other shaft.

Universal joints may have various forms, as shown by the illustration above, and may be used in various combinations. They find important application in naval ordnance.

An elementary universal joint, also called Cardan joint (after the Italian who was the first one to describe it) or a Hooke joint (after the Englishman who was the first one to use it), consists of two U-shaped yokes fastened to the ends of the shafts to be connected. Within these yokes there is a cross-shaped part which holds the yokes together.

When Hooke joints are used, the driver shaft and the driven shaft are joined by an intermediate shaft. All shafts are located on the same plane, and the coupling pins are


END DISKS ARE PINNED TO SHAFTS
LUG
CENTER DISK
LOCKING SPRING
COIL SPRING
BENT WIRE TO BE PUT THROUGH LUGS
LOCKING SPRING IS PUT IN HERE
COIL SPRING

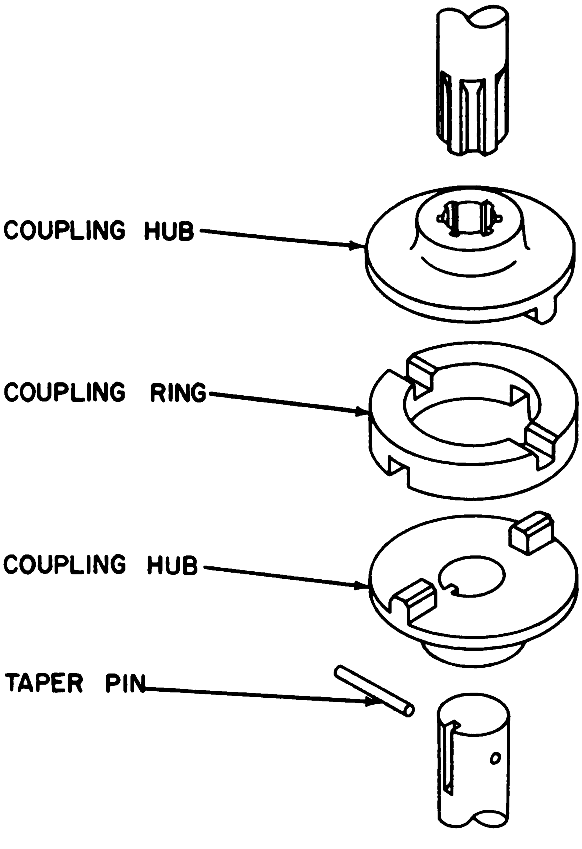
82. OLDHAM COUPLING

parallel to each other. This type of joint is used in the Vicker's axial piston pump.

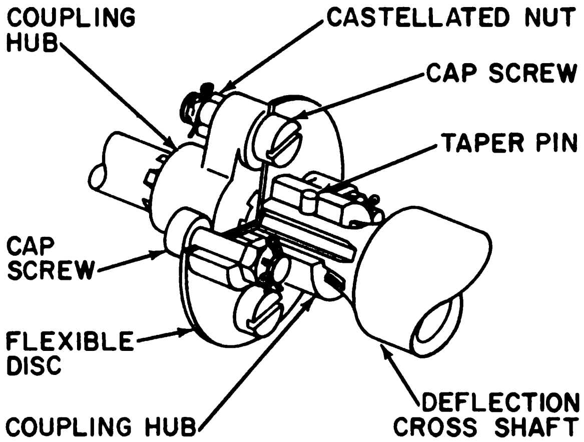
The Bendix-Weiss joint is designed to maintain constant velocity of shaft rotation, regardless of the angle of the shafts. The Bendix-Weiss joint is used in the A-ends of train and elevation power drives on many 5"/38 single mounts.

An Oldham coupling, as shown in the illustration above, consists of a pair of disks of which one is flat and the other hollow. These disks are pinned to the ends of the shafts. A third (center) disk, with a pair of lugs projecting from each face of the disk, fits into the slots between the two end disks and thus enables one shaft to drive the other shaft. A coil spring, housed within the center and the hollow end disk, forces the center disk against the flat disk. When the coupling is assembled on the shaft ends, a flat lock spring is slipped into the space around the coil spring. The ends of the flat spring are formed so that when the flat spring is pushed into the proper place, the ends of the spring are pushed out and locked around the lugs. A lock wire is passed between the holes drilled through the projecting lugs to guard the assembly. The coil spring compensates for any change in shaft length. (Shaft length may vary due to changes in temperature.)

Oldham couplings have one important feature: They can be easily connected or disconnected. Oldham couplings are used to join shafts which do not require perfect alinement. They are also used between the pump and the electric motor in the rammers of 5"/38 gun mounts.



83. FIXED COUPLING



84. FLEXIBLE COUPLING

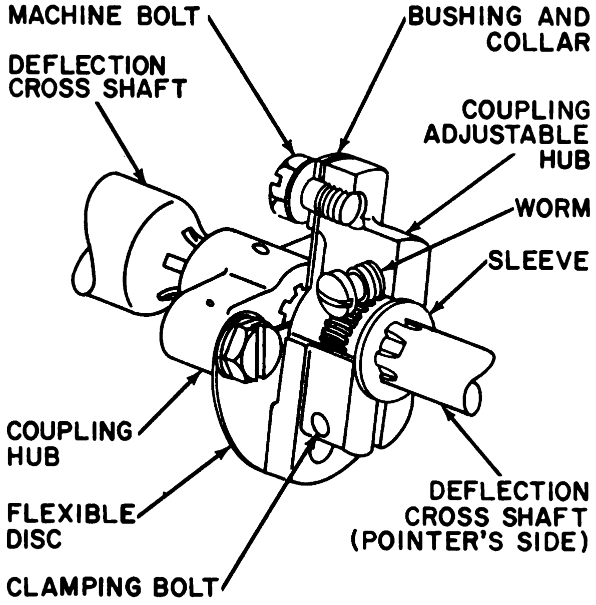
The following four types of couplings are used quite extensively in ordnance equipment, for example, in the 5"/38 gun sight system.

1. The fixed (sliding lug) coupling is nonadjustable; however, it does allow for a small amount of misalinement in shafting.

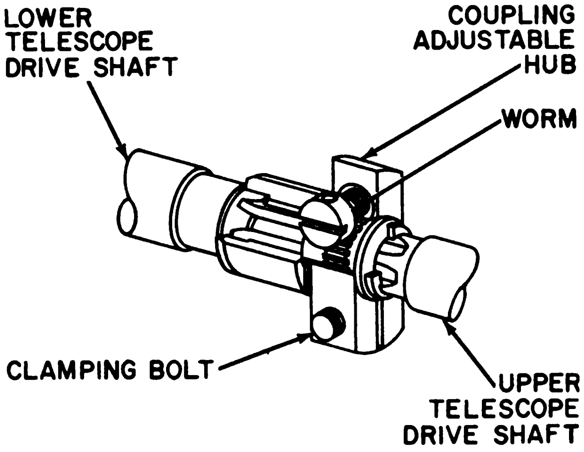
2. The flexible coupling connects two shafts by means of a metal disk. Two coupling hubs, each splined to its respective shaft, are bolted to the metal disk. The flexible coupling provides a small amount of flexibility to allow for a slight axial misalinement of the shafts.

3. The adjustable (vernier) coupling provides a means of rotating the shaft so that the optics are in correspondence with the dial indication and the gun position.

4. The adjustable flexible (vernier) coupling joins the metal disk of the flexible coupling with the adjustable element of the adjustable coupling. Several types of the adjustable flexible coupling are used in the shafting of the 5"/38 gun sight system. (See illustration below.)



86. ADJUSTABLE FLEXIBLE COUPLING



85. ADJUSTABLE COUPLING

QUIZ SHEETS:

1. To connect shafts at a 90° angle to each other, the following type of gears is used:

   a. Elliptical.
   b. Spur.
   c. Worm.
   d. Helical.

2. The gear used to rotate the driver and driven gear in the same direction is called:

   a. Spiral.
   b. Miter.
   c. Rack and pinion.
   d. Idler.

3. The driver gear and driven gear of an internal pinion gear rotate in opposite directions.

   True__________or False_________.

4. What is the gear ratio between a 30-tooth driver gear and a 10-tooth driven gear?

   a. 3 : 1.
   b. 1 : 3.
   c. 30 " 10.
   d. 10 : 3.

5. Bevel gears are used to connect shafts at a 30° angle.

   True__________or False_________.

6. The gear speed depends on the number of teeth in the pitch circle.

   True__________or False_________.

7. The main purpose of cams is to change

   a. Linear motion to rotary motion.
   b. Lateral motion to circular motion.
   c. Rotary motion to linear motion.
   d. Circular motion to rotary motion.

8. The outer edge of the plate of a face cam is elliptical.

   True__________or False_________.

9. The type of cam used to open the breech mechanism after firing of a 40 MM gun is called

   a. Profile.
   b. Face.
   c. Edge.
   d. Barrel.

10. If both end gears of a differential are rotated in opposite directions at the same speed, the output on the spider is equal to

    a. One-quarter output of both end gears.
    b. One-half output of both end gears.
    c. Zero.
    d. The sum of the outputs of both end gears.

11. If the spider of a differential is held, the output ratio of one end gear to the other end gear is 1 : 1, and both gears rotate in opposite directions.

    True__________or False_________.

12. The operation of a mechanical pencil is similar to the operation of one of the following differentials:

    a. Spur type.
    b. Bevel type.
    c. Screw type.
    d. Barrel type.

13. To adjust linkage, a clevis or turnbuckle is normally used.

    True__________or False_________.

14. A universal joint is used for coupling two parallel shafts.

    True__________or False_________.

15. To maintain constant velocity of shafts regardless of their angle, one of the following devices is used:

    a. Fixed coupling.
    b. Flexible coupling.
    c. Bendix-Weiss joint.
    d. Oldham coupling.

Accuracy of notes checked by instructor:

Date ______________________________

Trainee's initials______________________

Section 6

WEAPON SYSTEM HYDRAULICS

ASSIGNMENTS—DISCUSSION

Topic No.	Topic Title	Page
3 through 23	See NAVPERS 92662, Vol. 1	122

TOPICS 3 THROUGH 23

You Are Now Going to Learn:

1. Refer to appropriate topics in NAVPERS 92662, Vol. 1, Section 1.

You Will Acquire Skill in:

1. Refer to appropriate topics in NAVPERS 92662, Vol. 1, Section 1.

Discussion Points for these Topics Are:

1. Refer to appropriate topics in NAVPERS 92662, Vol. 1, Section 1.

ASSIGNMENT:

A. Reference publication:

   1. Study NAVPERS 92662, Vol. 1, Section 1, Topics 3 through 23.

INFORMATION AND DISCUSSION:

The discussion points for Topics 3 through 23, are thoroughly covered in the assignment. Study the text carefully and in proper sequence.

Section 7

SMALL ARMS

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Introduction to Small Arms	124
2.	.45 Caliber Piston M1911A1	126
3.	U. S. Rifle Caliber .30, M1	128
4.	Carbine, Caliber .30 M1	130
5.	Line-Throwing Gun and Projectile	132
6.	.45 Caliber Submachinegun M1	134
7.	Winchester Shotgun M12	136
8.	Browning Automatic Rifle M1918A2 (BAR)	138
9.	Browing Machinegun Caliber .30 M1919A4 (Light)	140

TOPIC 1: INTRODUCTION TO SMALL ARMS

You Are Now Going to Learn:

1. General information about small arms.

Discussion Points for this Topic Are:

1. Cycle of operation.
2. Automatic system.
3. Semiautomatic system.
4. Types of operating systems
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10185, Chapter 11, pages 224 through 227.

   2. Optional reading list:

      a. FM23-5.
      b. Guide Book for Marines.

INFORMATION AND DISCUSSION:

The discussion points listed for this topic are thoroughly covered in the assignment.

TOPIC 2: .45 CALIBER PISTOL M1911A1

You Are Now Going to Learn:

1. General characteristics, and operation of the .45 caliber pistol M1911A1.

You Will Acquire Skill in:

1. Disassembly of the .45 caliber pistol.
2. Assembly of the .45 caliber pistol.

Discussion Points for this Topic Are:

1. Characteristics and operation.
2. Disassembly.
3. Assembly.
4. Safety precautions.
5. Cycle of operation.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

    1. Study NAVPERS 10185, Chapter 11, pages 227 through 234.
    2. Optional reading list:
        a. FM23-35.

INFORMATION AND DISCUSSION:

The discussion points for this topic are throughly covered in the assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Disassemble the .45 caliber pistol.
2. Assemble the .45 caliber pistol.

TOPIC 3: U. S. RIFLE CALIBER .30, M1

You Are Now Going to Learn:

1. General characteristics and operation of the U. S. Rifle Caliber .30, M1.

You Will Acquire Skill in:

1. Disassembly of the U. S. Rifle Caliber .30, M1.
2. Assembly of the U. S. Rifle Caliber .30, M1.

Discussion Points for this Topic Are:

1. General characteristics and operation.
2. Disassembly.
3. Assembly.
4. Cycle of operation.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10185, Chapter 11, pages 235 through 242.
   2. Optional reading list:
      a. FM23-5.
      b. Guide Book for Marines.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in the assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Disassemble the caliber .30 M1 rifle.
2. Assemble the caliber .30 M1 rifle.

TOPIC 4: CARBINE, CALIBER .30 M1

You Are Now Going to Learn:

1. General characteristics and operation of the Carbine caliber .30, M1.

You Will Acquire Skill in:

1. Disassembly of the Carbine caliber .30, M1.
2. Assembly of the Carbine caliber .30, M1.

Discussion Points for this Topic Are:

1. Characteristics and operation of the Carbine caliber .30, M1.
2. Disassembly.
3. Assembly.
4. Cycle of operation.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

  1. Study NAVPERS 10185, Chapter 11, pages 242 through 247.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in the assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Disassemble the Carbine caliber .30, M1.
2. Assemble the Carbine caliber .30, M1.

TOPIC 5: LINE-THROWING GUN AND PROJECTILE

You Are Now Going to Learn:

1. General characteristics and nomenclature of the .45 caliber Line Throwing Gun and Projectile.

Discussion Points for this Topic Are:

1. Characteristics and nomenclature.
2. Shot line and cartridge.
3. Projectile.
4. Firing.
5. Maintenance.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10185, Chapter 11, pages 247 through 249.

   2. Optional reading list:

      a. OP 546.

INFORMATION AND DISCUSSION:

The discussion points listed for this topic are thoroughly covered in the assignment.

TOPIC 6: .45 CALIBER SUBMACHINEGUN M1

You Are Now Going to Learn:

1. General characteristics and operation of the .45 Submachinegun, M1.

You Will Acquire Skill in:

1. Disassembly of the .45 caliber Submachinegun.
2. Assembly of the .45 caliber Submachinegun.

Discussion Points for this Topic Are:

1. Characteristics and operation.
2. Disassembly.
3. Assembly.
4. Cycle of operation.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

    1. Study NAVPERS 10185, Chapter 11, pages 249 through 251.
    2. Optional reading list:
        a. FM23-40.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in the assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Field strip the .45 caliber submachinegun.
2. Assemble the .45 caliber submachinegun.

TOPIC 7: WINCHESTER SHOTGUN M12

You Are Now Going to Learn:

1. General characteristics and operation of the Winchester Shotgun M12.

Discussion Points for this Topic Are:

1. Characteristics and nomenclature.
2. Loading and Firing.
3. Cycle of operation.
4. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10185, Chapter 11, page 252, paragraph 4, column 2, and pages 258 through 261.
   2. Optional reading list:
      a. TM9-285.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in the assignment.

TOPIC 8: BROWNING AUTOMATIC RIFLE M1918A2 (BAR)

You Are Now Going to Learn:

1. General characteristics and operation of the Browning Automatic Rifle (BAR).

You Will Acquire Skill in:

1. Disassembly of the BAR.
2. Assembly of the BAR.

Discussion Points for this Topic Are:

1. General characteristics and operation.
2. Disassembly.
3. Assembly.
4. Cycle of operation.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

  1. Study NAVPERS 10185, Chapter 11, pages 261 through 268.
  2. Optional reading list:
     a. Guide Book for Marines.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in the assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Disassemble the BAR.
2. Assemble the BAR.

TOPIC 9: BROWNING MACHINEGUN CALIBER .30, M1919A4 (LIGHT)

You Are Now Going to Learn:

1. General characteristics and operation of the Browning Machinegun, caliber 30.

You Will Acquire Skill in:

1. Disassembly of the Browning Machinegun caliber 30.
2. Assembly of the Browning Machinegun caliber 30.

Discussion Points for this Topic Are:

1. Characteristics and operation.
2. Disassembly.
3. Assembly.
4. Cycle of operation.
5. Review and summary.
6. Section review.
7. Written test.

ASSIGNMENT:

A. Reference publications:

   1. Study NAVPERS 10185, Chapter 11, pages 268 through 275.
   2. Optional reading list:
      a. TM9-2005.
      b. Guide Book for Marines.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in the assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Disassemble the Browning Machinegun, caliber . 30.
2. Assemble the Browning Machinegun, caliber . 30.

Section 8

GUNS, MOUNTS, HOISTS, AND PLANNED MAINTENANCE SYSTEM

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Construction Features of Naval Gun Mounts	142
2.	Gun Assembly and Maintenance	146
3.	Semiautomatic Weapons	152
4.	Rapid-Fire Weapons	162
5.	Ammunition Hoists	170
6.	Planned Maintenance System	182

TOPIC 1: CONSTRUCTION FEATURES OF NAVAL GUN MOUNTS

You Are Now Going to Learn:

1. The arrangement and construction features of naval gun mounts.
2. Mount crew stations and duties.

Discussion Points for this Topic Are:

1. Purpose of a gun mount.
2. Open and enclosed gun mounts.
3. Difference between turrets and mounts.
4. Structural arrangement of a typical gun mount.
5. Stations and duties of a 5-inch gun crew.
6. Review and summary.

ASSIGNMENT:

A. Reference publication:

   1. Study NAVPERS 10783A, Chapter 4, pages 108 through paragraph 4D12 on page 120.

INFORMATION AND DISCUSSION:

A gun mount is defined as the supporting structure assembly and operating device for one gun or several guns.

The mounts may be either open or enclosed in a shield. Normally, open mounts are used on minor caliber and light machine guns, such as the 40 MM mount. The 3"/30 mounts are usually open, unless they are located on the main deck of small ships. The 5"/38 mounts are usually enclosed, except on auxiliary ships where they may be either enclosed or open. All 3"/70 and 5"/54 mounts are enclosed.

Gun mounts may support one, two, or four guns and are therefore classified as single, twin, or quad mounts. A brief listing of mounts classified in this manner and the caliber of guns they usually house follows:

Single mounts: 3"/50, 5"/38, 5"/54.

Twin mounts: 40 MM, 3"/50, 5"/38, 3"/70.

Quad mounts: 40 MM.

Turrets are classified separately from gun mounts. Turrets are totally enclosed and armored and contain two or three guns of 6-inch caliber or larger. (Gun mounts, even when enclosed, are not heavily armored and contain guns which are no larger than 5-inch in caliber.) Rocket and missile launchers are also equipped with mounts; some of these mounts are converted gun mounts.

Since the design of a 5"/38 single gun mount is typical, this mount is used to illustrate the structural features of gun mounts in general. The main assemblies of this mount are shown in the illustration on facing page and are listed below.

1. Stand assembly.
2. Carriage assembly.
3. Gun assembly.

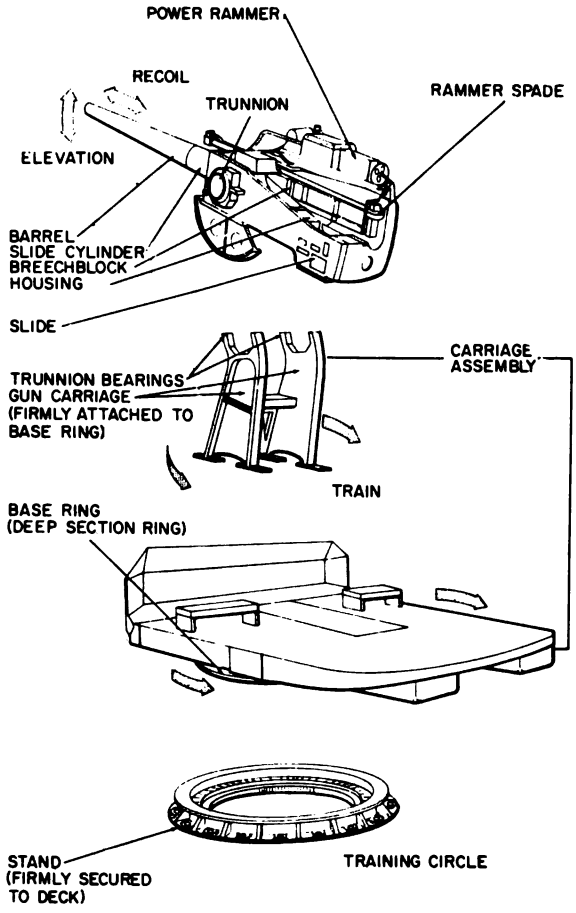
The stand serves as a base on which the parts of the mount rotate. It supports the entire mount and bears the stress induced by gunfire and roll of the ship.

Basically, the stand consists of a large circular steel casting with a flange around its rim for bolting the stand to the ship structure.

The inner surface of the stand is machined to accommodate the training circle which is keyed to the stand. The inner surface of the training circle is equipped with spur gear teeth that mesh with the train power drive output pinion.

The carriage assembly consists of the base ring and gun carriage.

The base ring (shown in the illustration) is a large rectangular weldment, consisting

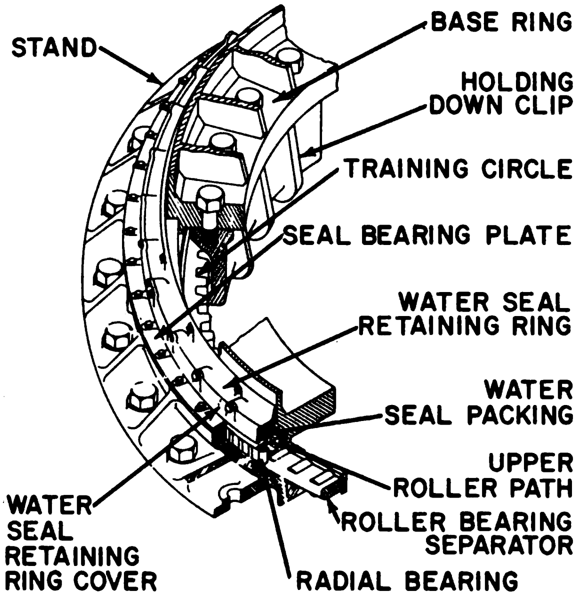


87. MAIN ASSEMBLIES OF A 5"/38 MOUNT

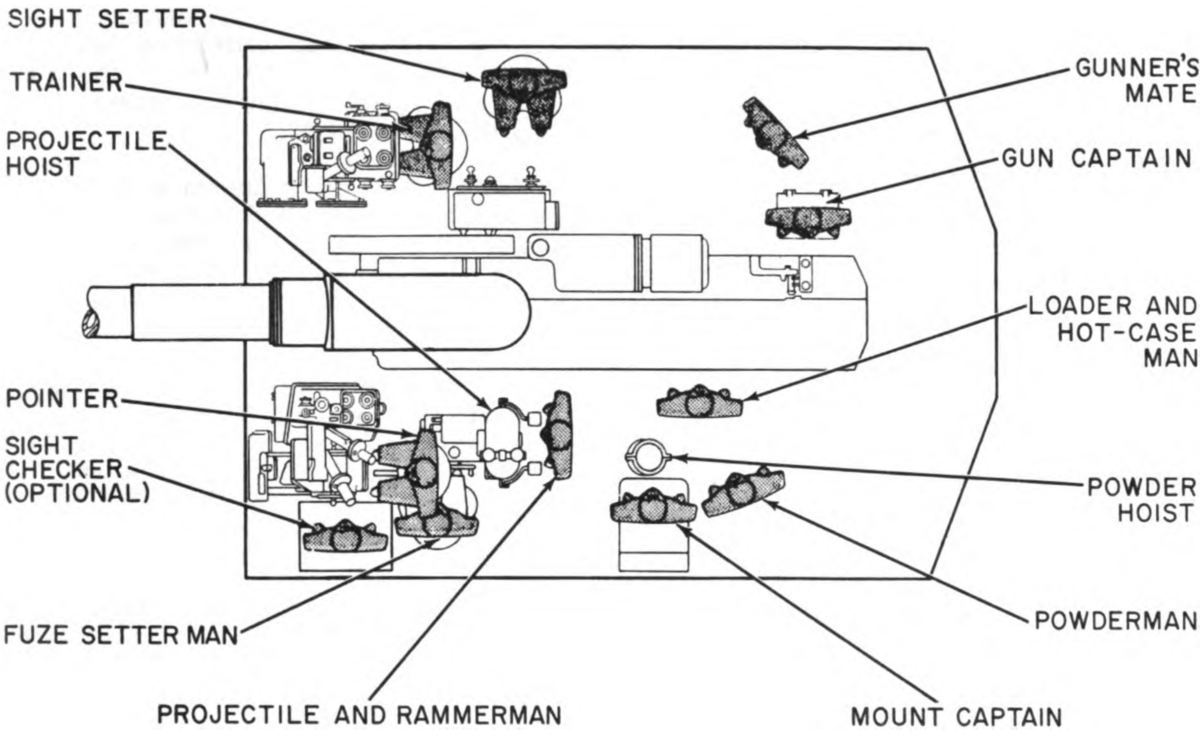
of two (fore and aft) girders that support the upper gun carriage and gun platform (not shown in the illustration). The lower portion of the base ring, which fits into the stand, is supported on roller bearings. Holding-down clips, bolted to the lower base ring, extend beneath the training circle, to prevent vertical movement of the mount when the gun is fired or when it is unbalanced, due to the movement of the ship. (The stand, roller bearings, training circle, lower base ring, and one of the holding-down clips are presented in the illustration below.

The carriage gun platform is bolted to the carriage girders and serves as a support for the mount power drive equipment, fuze setting devices, and ammunition hoist. This platform also serves as a work area for the gun crew.

The gun (upper) carriage consists of the cast steel brackets (cheeks) of the mount which support the gun assembly by means of trunnion bearings. (The gun assembly, which includes the slide, housing, breech assembly, and barrel, is described in Topic 2 of this section.)



88. STAND AND LOWER BASE RING



89. 5" SINGLE MOUNT CREW STATIONS

The crew stations of a 5"/54-caliber gun mount Mk 39 are shown in the illustration above. The mount arrangement and crew stations of a 5"/54 caliber gun mount Mk 39 are similar to the 5"/38 single mount.

The following is a brief description of the duties of individual crew members of a 5"/38 mount.

1. Mount captain - is responsible for the safety of the mount and the mount crew at all times and for enforcement of all applicable safety regulations. During firing in local control, the mount captain gives estimated range, deflections, and fuze settings to the applicable gun crew.

2. Gun captain - is directly responsible for the safety of his gun and gun crew. The gun captain operates the shell guard (rammer-spade) release.

3. Gunner's mate - acts as assistant to the gun and mount captains, also as troubleshooter and maintenance man, is capable of replacing any member of the gun crew.

4. Trainer - lays the gun in train, ensures that the mount remains matched with the director in train (automatic control), and keeps the vertical crosshair of the telescope on target (local control).

5. Pointer - lays the gun in elevation, insures that the mount remains matched with the director in elevation (automatic control), and keeps the horizontal crosshair of the telescope on target (local control).

6. Sight setter - keeps sight angle and sight deflection dials matched with the order dials in automatic control, and sets in range and deflection orders when mount captain is spotting in local control.

7. Fuze setter - keeps fuze setter indicator regulator matched with the order signal in local control and insures that the indicator regulator remains matched with the order signal in automatic control. Manually sets in fuze setting when mount captain is spotting in local control.

8. Projectile and rammer man - loads projectile in loading tray, actuates the rammer cycle, and observes the in battery marks and breech closed marks during firing.

9. Powderman - places powder case in loader tray after ensuring that the shell guard (rammer spade) is properly positioned for loading.

10. Hot case man - keeps the gun platform clear of hot powder cases.

11. In addition to the ten crewmen in the mount, there are six crewmen (two powdermen, two projectile and rammer men, and two passers) in the upper handling room and additional passers in the magazine.

TOPIC 2: GUN ASSEMBLY AND MAINTENANCE

You Are Now Going to Learn:

1. Classification and construction features of naval guns.

2. Care and maintenance of naval guns.

3. Interior ballistics.

Discussion Points for this Topic Are:

1. Classification of naval guns.

2. Construction features of the following gun components:

   a. Barrel.
   b. Housing.
   c. Breech mechanism.
   d. Slide.
   e. Recoil and counterrecoil systems.

3. Care and maintenance of naval guns.

4. Interior ballistics.

5. Erosion.

6. Review and summary.

INFORMATION AND DISCUSSION:

Guns are classified according to their purpose, the type of ammunition they fire, their caliber, the way they function, and the type of battery they are in.

According to their purpose, guns may be classified either as dual purpose or single purpose. A dual purpose gun can be used against both a surface and an air target; a single purpose gun can be used either against a surface or an air target, but not against both.

Turrets may be classified as having either either bag guns or case guns. In bag guns, the propelling charge is enclosed in raw silk bags; in case guns, metal powder cases are used.

All guns are classified by their caliber, which is the diameter of the bore measured from the top of the lands. (The lands are the raised parts of the barrel rifling.) Part of this caliber designation also includes the gun barrel length expressed in calibers. (For example, the 5-inch 38 caliber gun has a bore diameter of 5-inches and a gun barrel length equal to 5-inches times 38, or 190 inches.)

Another method of classifying guns by caliber is the grouping of guns into the following classes:

1. Major caliber - Includes guns from 8-inch to 16-inch.

2. Intermediate caliber - Includes 5-inch and 6-inch guns.

3. Minor caliber - Includes 4-inch and smaller guns.

4. Small arms - Include pistols, rifles, and machineguns up to 0.60-inch.

By the way they function, guns are classified as follows:

1. Single fire - Breech mechanism is always opened and closed by hand. The major caliber bag guns belong to this class.

2. Semiautomatic - Force of the explosion within the gun opens the breech, ejects the cartridge case, and cocks the firing mechanism; however, loading requires personnel to place a round in the breech or loading tray. The 5"/38 mount and 6"/47 three-gun turret are typical examples of semiautomatic guns.

3. Automatic - Force of the explosion within the gun is used to perform all loading and reloading operations. The 40 MM belongs to this class of guns.

4. Rapid-fire (RF) - Loading is performed by automatically actuated power equipment as long as the firing and loading circuits are closed. The breech mechanism can be opened either by force of the explosion or by power equipment, but not by both

together. The 3"/50, 3"/70, 5"/54 Mk 42, and 8"/55 case guns are typical examples of rapid-fire guns.

Aboard ship, guns may also be classified according to the battery to which they belong. The classes are as follows:

1. Main battery.
2. Secondary battery.
3. Antiaircraft battery.
4. Machinegun battery.

The types of guns that fit into each of these classes vary with the type of ship they are installed on. For example, the batteries on a cruiser equipped with turrets and mounts could be classified in the following manner:

1. Main battery - 8-inch turrets.
2. Secondary battery - 5"/38 mounts.
3. Antiaricraft battery - 3"/50 mounts.

On small ships (such as destroyers), the main battery would include 5"/38 guns, and the secondary battery would include 3"/50 guns. If the destroyer had 40 MM guns instead of the 3"/50 guns, the 40 MM guns could be classified as either machineguns or secondary battery guns.

With the Navy rapidly changing from guns to rockets and guided missiles, some of the gun batteries are being replaced by batteries of rocket launchers and guided missile launchers.

> NOTE: The term gun actually designates only the gun tube, or barrel, but is commonly used to refer to the whole assembly of which the barrel is only a part.

A typical gun assembly consists of the following units:

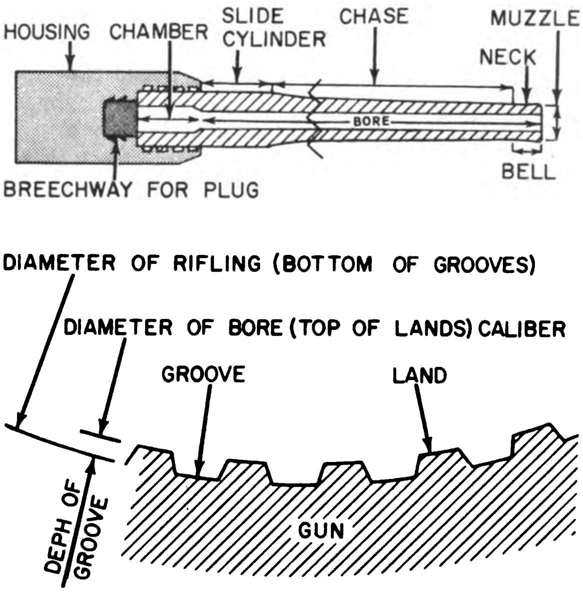
1. Barrel.
2. Housing.
3. Breech mechanism.
4. Slide.
5. Recoil and counterrecoil systems.

A gun barrel, as shown in the illustration below, is the tube in which the ammunition is fired and which controls the initial direction of the projectile. The aft end of the barrel contains an enlarged chamber which houses the propelling charge. The forward end of the chamber tapers down to the point where the bore begins.

From the point where the bore begins to the front of the barrel, or muzzle, the diameter is constant and rifled. The rifling consists of spiral grooves that are machined into the surface of the gun bore.

The bulkiest part of the gun barrel is its breech end where the metal is thickest, to withstand the high pressure developed when the gun is fired. The cylindrical aft part of the barrel is formed by the slide cylinder which, during recoil, moves in the slide on bearings.

Forward of the slide cylinder the barrel tapers. The tapering part, called the chase,



90. GUN BARREL, CUTAWAY VIEWS

extends a short distance from the muzzle, to a point where on many guns the barrel thickens and forms a bell. The narrow portion of the barrel, just aft of the bell, is called neck.

The rifling (spiraled lands and grooves) of a gun barrel imparts to the projectile a spin which increases the stability of the projectile in flight. In all Navy guns and small arms, except the .45 caliber pistol, the rifling has a right-hand twist.

The aft end of the case gun barrel is connected to the gun housing by a bayonet type joint. The housing provides a recess (breechway) for the breech mechanism and guideways for the slide.

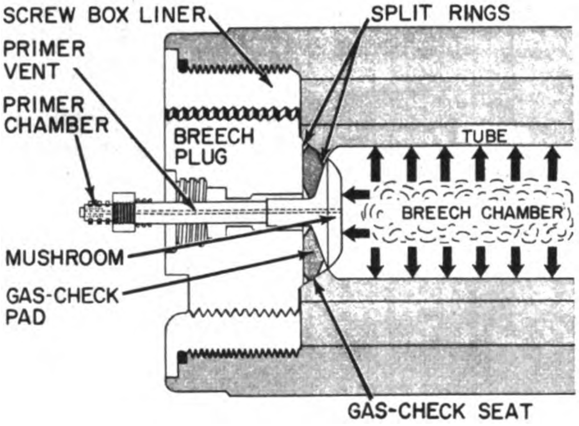
Major caliber bag guns are equipped with a yoke instead of a housing. The yoke construction is quite different from the housing construction, but their functions are similar.

The breech mechanism closes the aft end of the barrel when the gun is fired. Case guns are equipped with sliding wedge type breechblocks, while the bag guns use an interrupted screw breechplug. The plug type breech mechanism is manually operated and manually primed. (A primer must be inserted into a chamber to ignite the powder bags.)

The breech mechanism also seals the breech to prevent gas leakage during firing. The breech of all bag guns is sealed by a mushroom-shaped stem and a gas check pad on the face of the plug. (A simplified view of the plug type breech mechanism is presented in the illustration in the above adjacent column.)

The sliding wedge breechblock can be operated either hydraulically or mechanically. When it is mechanically operated, the powder case, by entering the breech, causes the breechblock to closed When the gun is fired, the breechblock is cammed open either by the recoil or counterrecoil of the gun. All breechblocks operate vertically, except the 3"/70 which slides horizontally.

A gas check apparatus is not used in case guns, because the force of the explosion and the heat of the burning propelling charge expand the powder case against the walls of the gun barrel chamber, thereby effectively sealing the breech. (A 5"/38 gun housing and sliding wedge breechblock are shown in the illustration at the top of facing page.)



91. INTERRUPTED SCREW BREECHPLUG

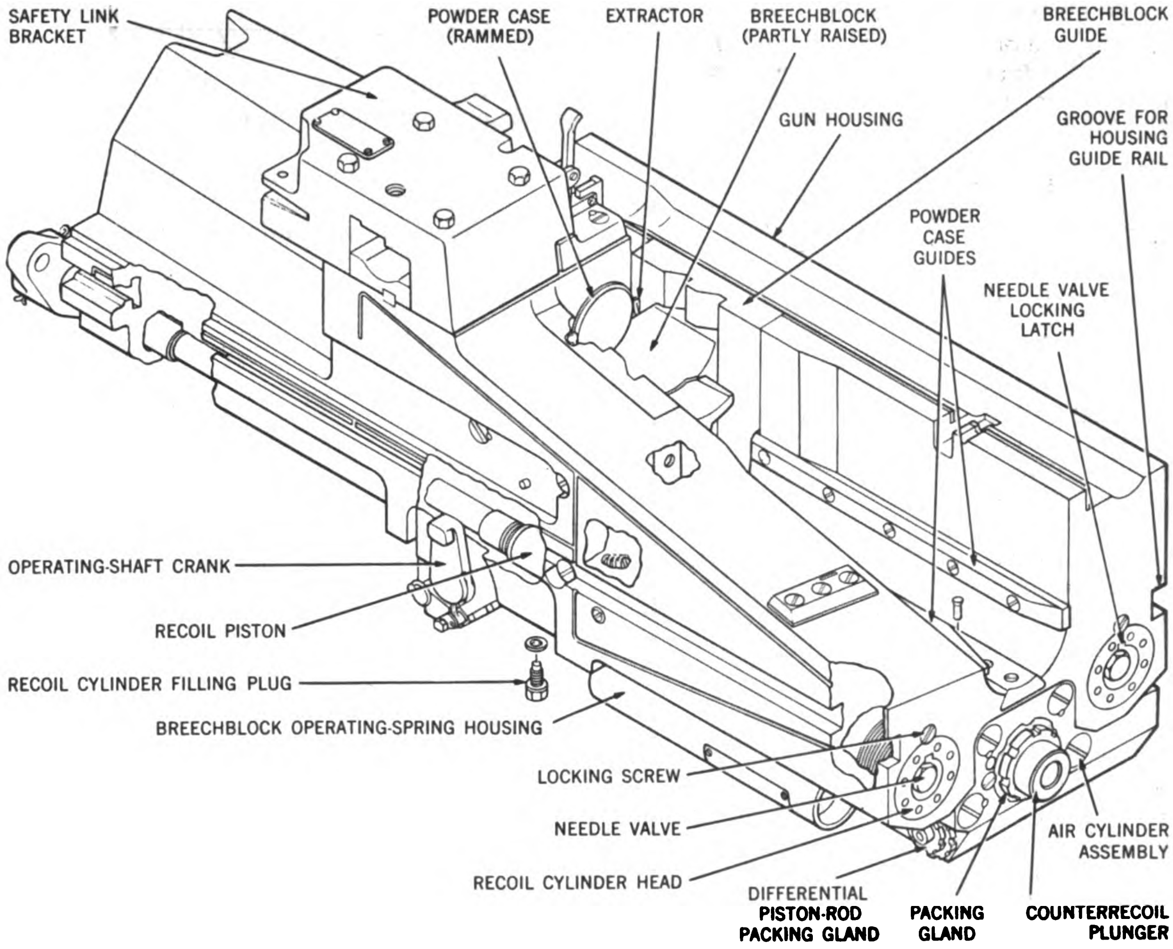
The slide is used only in case guns. The slide is an assembly which supports the gun barrel and housing and provides bearings for the barrel and housing to recoil on. The slide pivots vertically on trunnions and therefore is able to elevate and depress the gun barrel. (The slide, trunnions, and trunnion bearings are shown in the illustration at the bottom of facing page.)

When fired, all guns recoil violently, causing the gun to move rearward. The recoiling action is controlled by the recoil system. All Navy guns of 40 MM and larger use a hydraulic recoil brake which consists of a piston, cylinder, fluid, and a special device which permits the fluid to pass from one side of the cylinder to the other.

The rods, holes, or grooves which permit the fluid to pass from one side of the cylinder to the other are cut or tapered in such a manner that the recoil thrust is gradually decreased and eliminated.

The counterrecoil system helps the recoil system to stop the recoil of the gun and to return the gun to battery.

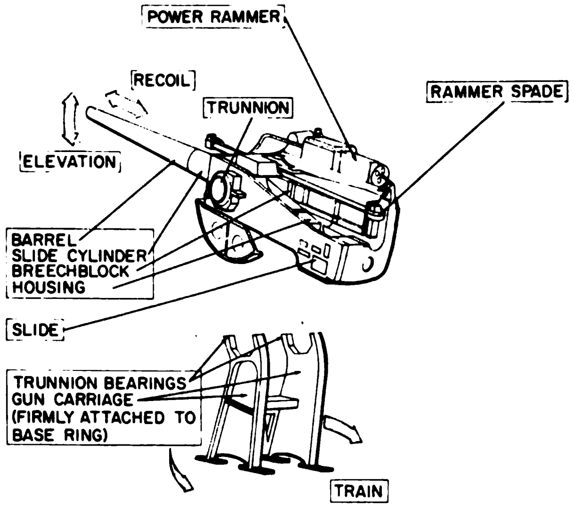
There are two basic types of counterrecoil systems: Guns smaller than 5-inch



92. 5"/38 GUN HOUSING AND BREECHBLOCK ASSEMBLY

(except for 3"/70 RF) use one or several recoil springs; guns 5-inch and larger are equipped with pneumatic systems which use air or nitrogen to provide the counterrecoil thrust. Since the counterrecoil systems are sealed under hydraulic pressure by means of packings, they are often called hydropneumatic counterrecoil systems. (The arrangement of the recoil and counterrecoil assemblies in a 5"/38 gun are shown in the illustration in adjacent column.

The case and maintenance of the gun mechanism is and always has been the first duty of a gunner's mate. The barrels must be cleaned, inspected, and oiled before and after firing and at regular intervals. The gun bore must also be gauged and decoppered whenever necessary.



93. GUN ASSEMBLY AND TRUNNION BEARINGS

The guns must be run out of battery before they are fired and also at regular intervals. For this purpose, the guns must be elevated; then the air must be slowly vented from the counterrecoil system.

The fluid in the recoil mechanism must also be replaced and checked at regular intervals.

The breech mechanism must be disassembled, cleaned, and inspected at intervals prescribed in the gun checkoff list. The more the gun is fired, the oftener the breech mechanism should be cleaned and inspected.

NOTE: Interior ballistics and the ef-effects of erosion are thoroughly covered in the reading assignment for this topic.

TOPIC 3: SEMIAUTOMATIC WEAPONS

You Are Now Going to Learn:

1. Definition and types of semiautomatic weapons used in the Navy.
2. Assembly arrangement and operation of the 5"/38 semiautomatic gun.

Discussion Points for this Topic Are:

1. Definition of semiautomatic weapons.
2. Types of semiautomatic weapons.
3. General arrangement and functions of the 5"/38 caliber gun mount components.
4. Operation of the 5"/38 caliber gun.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

  1. Study NAVPERS 10783A, Chapter 5, pages 154 through 164.

INFORMATION AND DISCUSSION:

A semiautomatic weapon is a gun that can be used either fixed or semifixed case type ammunition and which utilizes the energy of the explosion to operate the breech mechanism.

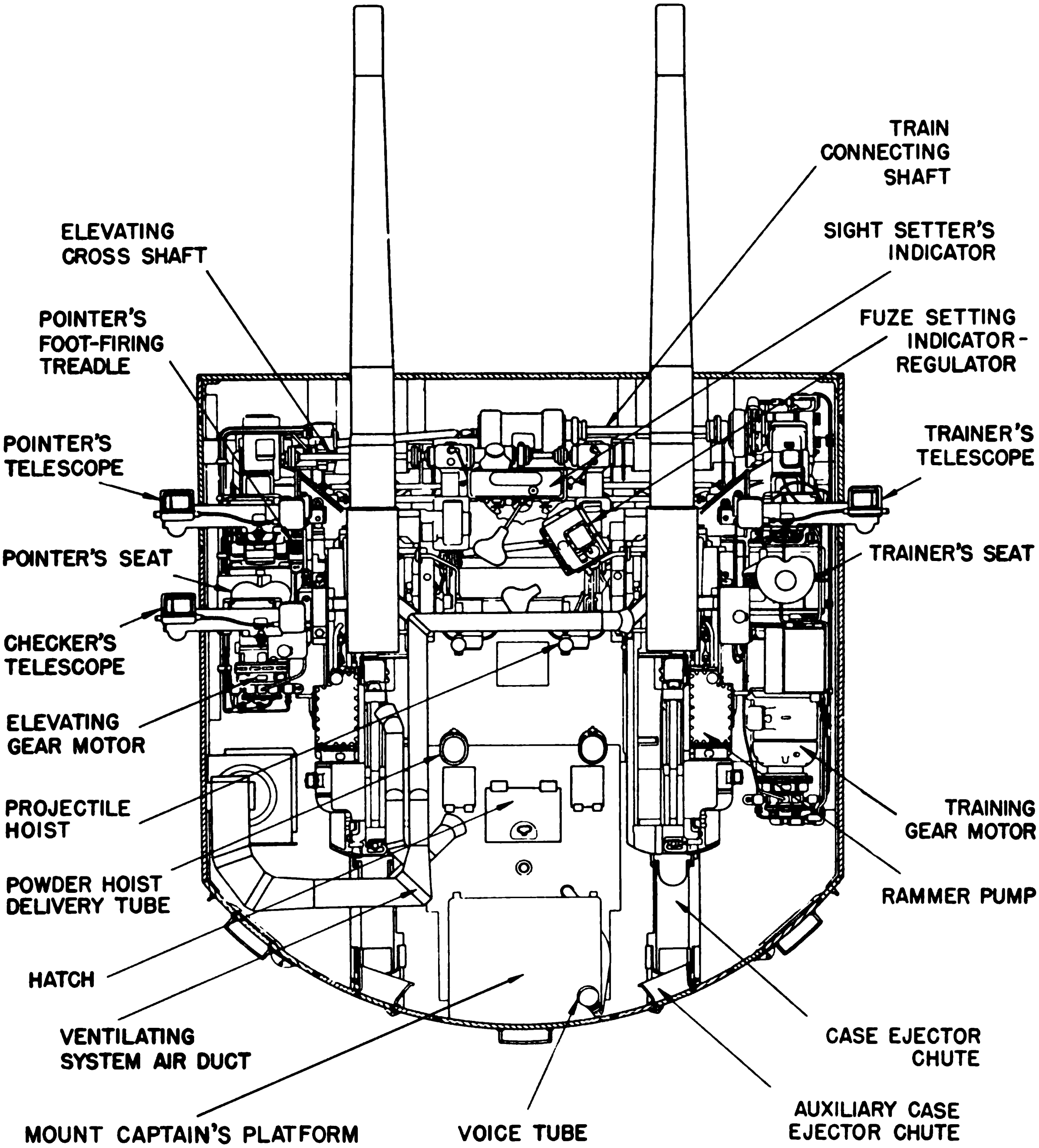
Semiautomatic guns must be loaded by hand; however, the breech mechanism is opened and the propellent case is extracted automatically when the gun, after being fired, is returning to battery. The breech mechanism is released so that it can be closed by spring action when a propellent case is loaded into the gun chamber.

The semiautomatic weapons now used in the Navy include the single and twin 5"/38 caliber gun mounts and the 5"/54 caliber single gun mount Mk 39. These two gun assemblies are alike, except that the 5"/54 gun has a longer barrel than the 5"/38.

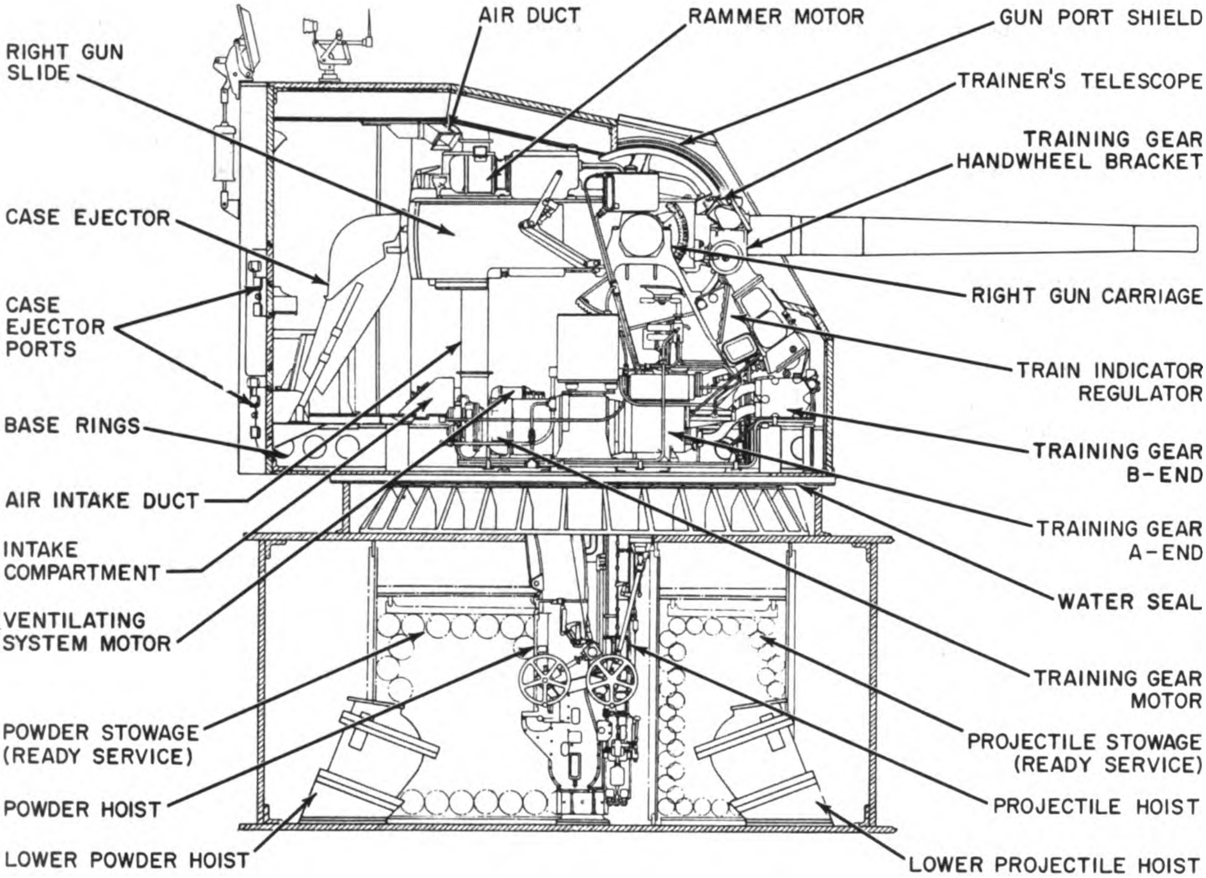
> NOTE: The 3"/50 caliber guns have similar breech mechanisms and are sometimes referred to as being semiautomatic; however, they have an automatic power loader and are rightly classified as being rapid-fire guns.

The 5"/38 gun is one of the most commonly used weapons in the Fleet. It is not a new type of gun, but its reliability, due to the basic soundness of its design, has insured its use up to the present, although it is far outranged by modern weapons. (The interior of the 5"/38 twin gun mount is shown in the illustration on facing page.)

Each 5"/38 gun mount is located directly above a handling room which provides space for storing a small amount of ready service ammunition and for transferring ammunition from the lower (magazine) hoists to the upper (gun) hoists. There are two methods of storing the ready service ammunition in the handling rooms: One method is the use of stationary racks as shown on page the other method, used on the newer 5"/38 twin mounts, is the use of trainable racks (merry-go-rounds) which encircle the entire handling room. The projectiles and powder cases in the trainable racks are stowed in upright position for ready use. The trainable racks are driven by an electric motor and can be rotated and stopped in any position by means of pushbutton controls.



94. 5"/38 TWIN MOUNT, GENERAL ARRANGEMENT



95. 5"/38 TWIN MOUNT, GUN AND HANDLING ROOMS

The 5"/38 twin gun mounts consist of the following major assemblies:

1. Vertical sliding wedge breech mechanism.
2. Electric and percussion firing mechanism.
3. Hydraulic recoil and hydro-pneumatic counterrecoil systems.
4. Power operated rammer.
5. Power operated elevating and training gear assemblies.
6. Movable prism type telescopes.
7. Power operated fuze setting projectile hoists.
8. Power operated powder hoists.

The breech mechanism, firing mechanism, recoil and counterrecoil mechanisms, and the power rammer will be explained later in this topic when gun operation will be discussed.

The training and elevating gear assemblies include the power drives, receiver regulators, and gearings required for manual and power operation of the gun mount. Although power drives of the 5"/38 single mounts and twin mounts are both electrically and hydraulically operated, they differ in their types of control and methods of operation. The 5"/54 mount Mk 39 is equipped with all electric, amplidyne power drives.

All three mounts use separate power units for elevation and train. The general location of the power drives and control stations of all mounts are similar. The power drive for the 5"/38 twin mount is described in the reading assignment for this topic.

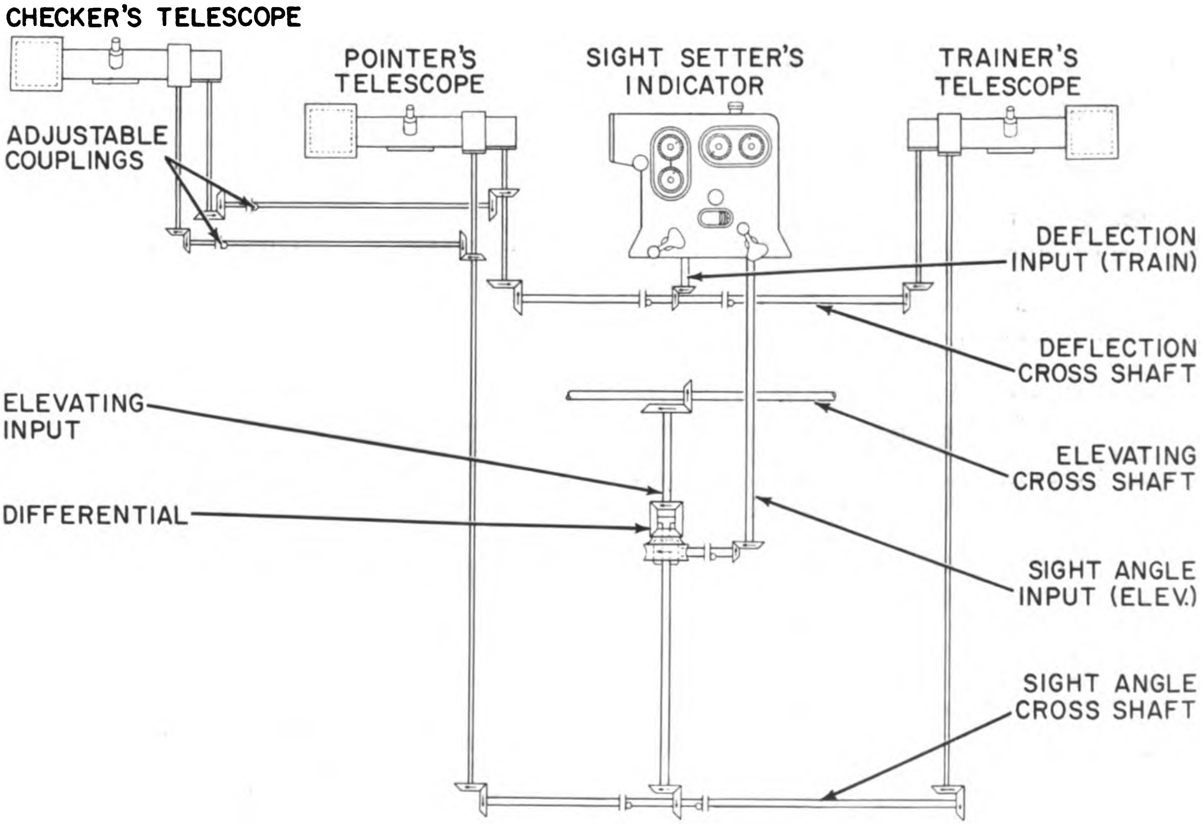
Three movable prism type telescopes are mounted in the 5"/38 and 5"/54 mounts. The telescopes are located at the pointer, trainer, and safety observer (checker's) stations.

Each telescope has a reticle with a vertical and a horizontal crosshair which help to accurately establish the line of sight (L. O. S.) to the target: The pointer elevates or depresses the gun to get the horizontal crosshair on the target, and the trainer trains the mount to get the vertical crosshair on the target.

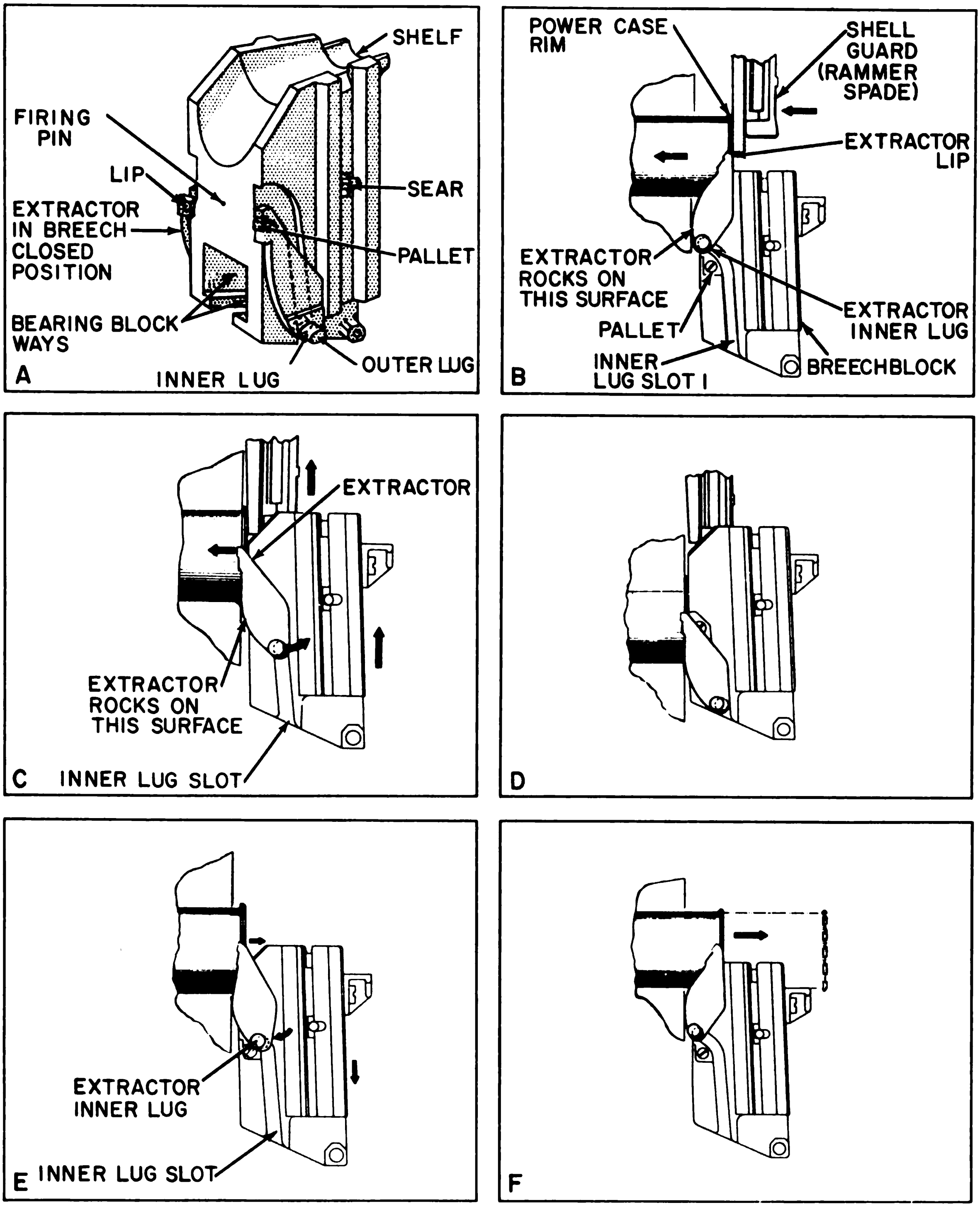
The offsetting of the telescope with the gun bore axis is the duty of the sight setter. This action is accomplished by sending the computed value of the sight angle and sight deflection to be used by phone or by indicating them by dials to the sight setter. Two handcranks are provided on the sight setter's indicator, to shift the telescope prisms vertically for sight angle and horizontally for sight deflection. (The mechanical arrangement of the telescopes and sight setter's indicator is shown in the illustration below.)

The 5"/38 breech mechanism consists of the following major components:

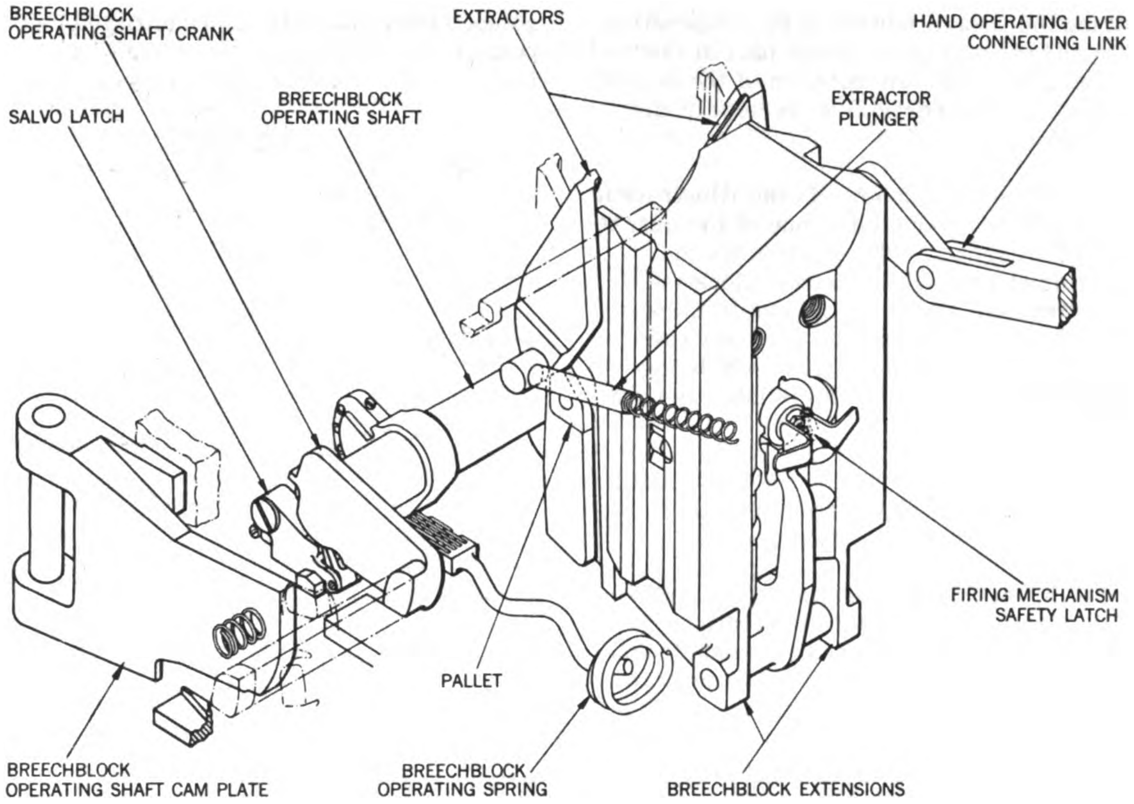
1. Breechblock.
2. Extractors.
3. Breechblock operating shaft.
4. Salvo latch.
5. Breechblock operating spring (breech closing spring).
6. Breechblock operating shaft cam plate (breech opening cam).
7. Hand operated lever.



96. 5"/38 SIGHTS AND SIGHT SETTER'S INDICATOR ASSEMBLY



97. 5"/38 BREECHBLOCK (A--MAIN PARTS; B, C, D, E, F--STEPS IN FUNCTIONING)


BREECHBLOCK OPERATING SHAFT CRANK
EXTRACTORS
HAND OPERATING LEVER CONNECTING LINK
SALVO LATCH
BREECHBLOCK OPERATING SHAFT
EXTRACTOR PLUNGER
FIRING MECHANISM SAFETY LATCH
PALLET
BREECHBLOCK OPERATING SHAFT CAM PLATE
BREECHBLOCK OPERATING SPRING
BREECHBLOCK EXTENSIONS

98. BREECH MECHANISM

The breechblock is a vertical sliding wedge that rides in vertical grooves which are cut into the gun housing. The face of the breechblock and the breechblock guides slant forward so that when the block rises, it wedges the cartridge case into the gun chamber.

A machined bore in the breechblock houses the firing mechanism. The block also contains machined guideways for the operation of the extractors and the breech opening bearing blocks.

Two extractors, located on each side of the breechblock, extract the cartridge case from the gun after it has been fired. The extractors also hold the breechblock open until another round has been loaded into the gun chamber. Each extractor has two lugs: The outer lug rides in a kidney shaped slot in the breech housing, while the inner lug rides in the breechblock extractor camway (inner lug slot). (The breechblock and extractor operations are presented in the illustration on facing page.)

The breechblock operating shaft, secured by bearing caps to the bottom of the gun housing, automatically opens the breechblock by cam action during the firing cycle. The operating shaft can also be rotated by a hand operated lever, to open the breechblock.

A crank is located on each end of the operating shaft. The crank, shown in the illustration above, contains a lug which contacts the breech operating shaft cam plate during counterrecoil, forcing the crank to rotate downward and, by means of the operating shaft and bearing blocks, causes the breechblock to open.

The opposite end of the operating shaft has a crank which engages with the hand operated lever linkage. Near the left end of the operating shaft is a camlike arm to which the breechblock operating spring chain is attached.

Near the center of the operating shaft are the arms which support the bearing blocks. These bearing blocks slide in the inclined bearing blockways (shown in the illustration on page 156) within the lower part of the breechblock; thus, the rotation of the operating shaft causes vertical movement of the breechblock.

The salvo latch (shown in the illustration on page 157) is mounted to one of the operating shaft bearings. The latch locks the operating shaft when the breechblock is closed (raised) and when the gun is in battery. This safety measure prevents the breechblock of an unfired gun from being accidentally opened unless the latch is first tripped by hand.

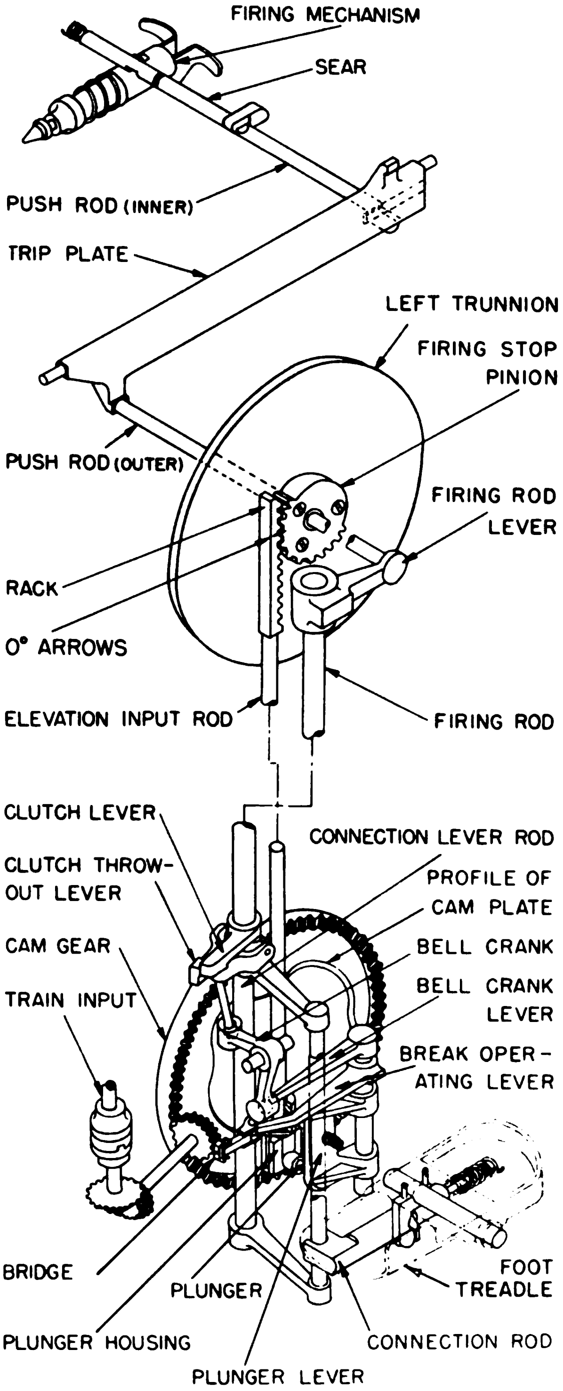
When, after being fired, the gun recoils, a cam unlocks the salvo latch and allows the breech to open during counterrecoil.

The breechblock operating spring assembly (partially shown in the illustration on page 157) is connected to the breechblock operating shaft and provides the energy to close the breechblock. The spring tension is regulated by an adjusting nut, to control the force by which the breech closes.

The breechblock operating cam plate is connected by a hinge to the gun slide. One end of the cam plate is spring loaded away from the slide. During recoil, the breechblock operating shaft crank passes by the cam. As soon as the crank gets aft of the cam, the spring moves the cam outward into the path of the counterrecoiling lug on the operating shaft crank. When the lug strikes the curved position of the cam plate, the operating shaft is rotated and the breech opens.

The hand operated lever is provided for opening the breech by hand. The lever is connected to the slide and does not recoil; therefore, the lever and operating shaft are connected in such a manner that they are engaged only when the gun is in battery.

The firing mechanism (lock), located in the breechblock, provides the means for percussion and electrical firing. Electrical firing requires that the firing pin be electrically insulated from the gun, but be in contact with the primer when the breech is closed. The voltage for firing the gun electrically is provided either by the ship supply or by a battery located in the handling room. Percussion firing is initiated by the pointer depressing a foot treadle. When the foot treadle is depressed, a system of



99. FIRING MECHANISM AND PERCUSSION FIRING LINKAGE

linkages and pushrods move the sear inward, releasing the firing mechanism.

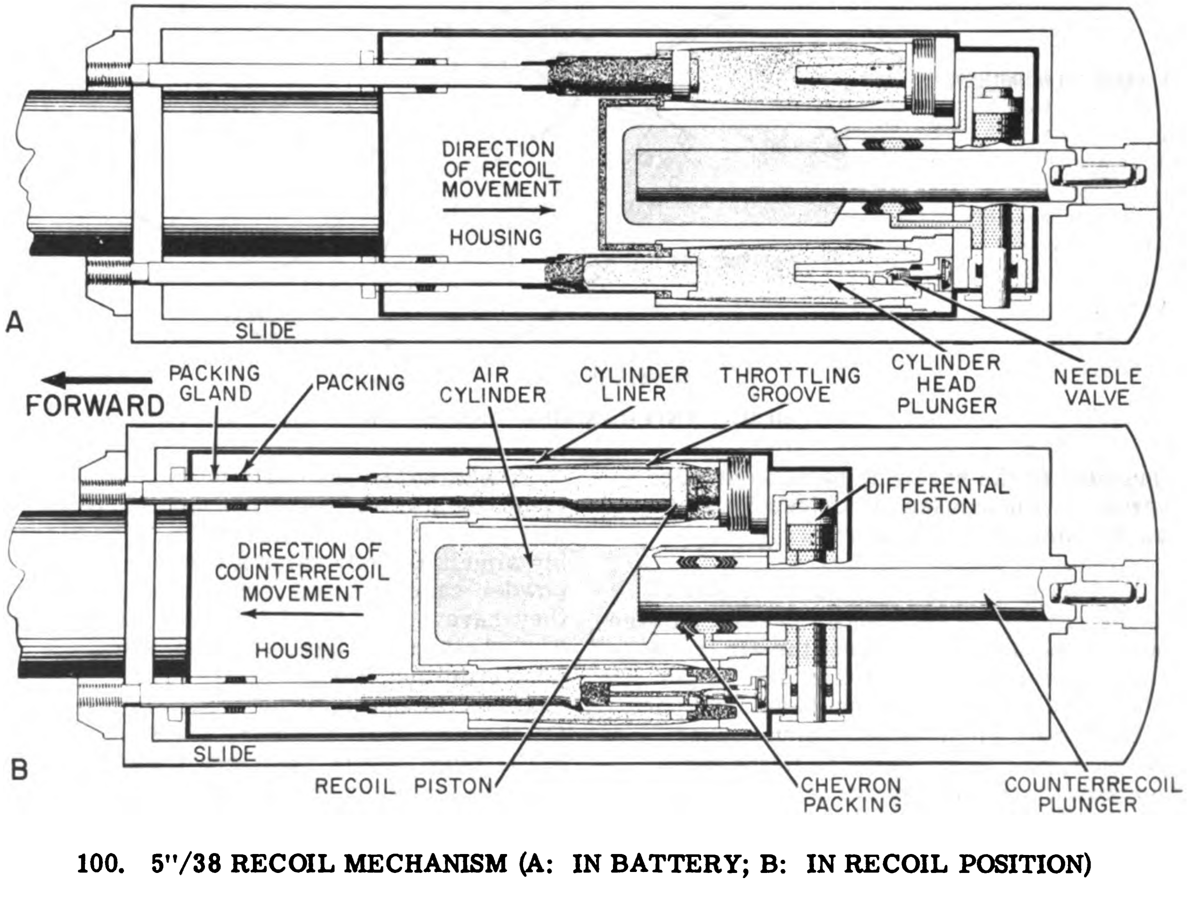
A profile cam plate is provided to prevent the gun from being fired by percussion when the gun is pointing into an unsafe zone (ship superstructure). The firing mechanism is cocked when the breechblock is opened by a retracting lever that is pivoted between the breechblock extensions. (The breechblock extensions are shown in the illustration on page 157; the firing mechanism and linkage to the foot firing treadle are shown in the illustration on facing page.)

The recoil system is equipped with pistons working in hydraulic twin cylinders, to absorb the major shock of recoil and to provide a buffer for counterrecoil. The piston rods are connected to the slide. The cylinders are formed by bores in the gun housing; therefore, the pistons remain stationary, while the cylinders move during recoil and counterrecoil.

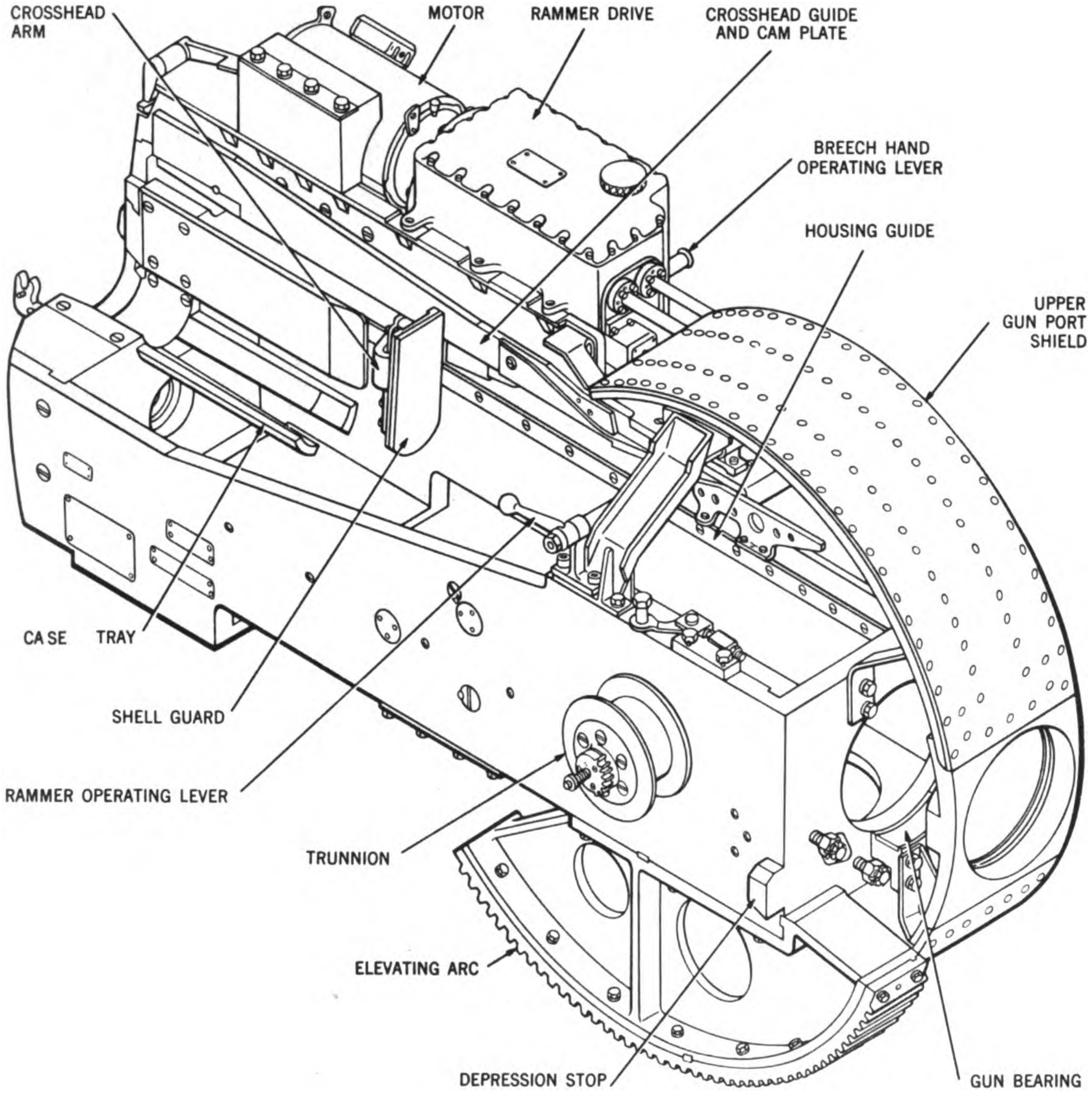
Throttling grooves of variable depth, located in the cylinder walls, control and throttle the amount of hydraulic fluid that passes around the piston head during recoil, insuring the proper rate of recoil braking action. Valves in the cylinder head are provided to buff the gun when it returns to battery after recoil.

The counterrecoil system is hydropneumatically operated. The air cylinder is formed by a bore in the aft part of the gun housing. A highly polished plunger, extending through a double chevron packing out of the cylinder, is coupled to the aft end of the slide by a support block and support bar. When the gun is in battery, the air in the cylinder prevents the gun from moving to the rear.

During recoil, when the gun and housing move to the rear, the air pressure increase and helps the recoil system to stop the recoil movement of the gun. When the rearward



100. 5"/38 RECOIL MECHANISM (A: IN BATTERY; B: IN RECOIL POSITION)



101. SLIDE AND RAMMER ASSEMBLIES

movement of the recoiling parts is stopped, the highly compressed air drives the gun and housing forward into battery.

A differential piston (small area side) supplies hydraulic fluid under pressure to the chevron packings, to prevent the air from escaping around the counterrecoil plunger. The hydraulic fluid is pressurized by a port, drilled in the gun housing, which connects the counterrecoil air cylinder to the large area side of the differential piston. (The recoil and counterrecoil systems are shown in the illustration on the preceding page.)

The rammer assembly (shown above) is a manually actuated electro-hydraulic power unit, located on top of the slide. The assembly simultaneously rams a projectile and a powder case into the gun chamber after they have been placed into the loading tray. The shell guard (spade) which rams the projectile and powder case into the gun chamber is operated by a hydraulic piston. On the new type rammers used on the 5"/38 twin mounts, the piston rod movement is transmitted to the spade through a rack and pinion gear arrangement which permits the spade to move a distance twice as great as the distance which the piston rod moves.

When the 5"/38 gun is fired, the sequence of the operating cycle is as follows:

During recoil, the force of the expanding gases causes the barrel and housing assemblies to move rearward within the slide. During the first part of recoil, the salvo latch is disengaged and the operating shaft is free to rotate. The braking (retarding) action of the recoil and counterrecoil systems stops the rearward action, and the compressed air moves the recoiling parts forward again. This forward movement is checked and smoothed by the dashpot and buffing action within the recoil cylinder.

During counterrecoil, the operating shaft is rotated upon contact with its cam plate. This rotation opens the breechblock, retracts the firing pin, sets the sear, and compresses the operating spring. As the breech opens, the outer lugs of the extractors are thrust forward by their plungers, while the inner lugs are moved forward by their slotted camways in the breechblock. The lips of the extractors snap to the rear, thereby extracting the empty case, and the inner lugs come to rest on the pallets, thus holding the breechblock down against the pressure of the operating spring.

When the next round is rammed, the cartridge case trips the extractors, rocking the inner lugs off the pallets. The block rises, wedging the cartridge case, moving the retracting lever to permit the firing pin to contact the primer, and bringing the sear in line with the inner pushrod of the foot firing mechanism. Simultaneously, as the operating shaft rotates, the latching lug on the shaft picks up the salvo latch pawl and enables the salvo latch to lock the breech. The gun is now ready to fire the next round.

TOPIC 4: RAPID-FIRE WEAPONS

You Are Now Going to Learn:

1. Definition of rapid-fire weapons.
2. The 3"/50 rapid-fire gun mount assemblies and their operation.

Discussion Points for this Topic Are:

1. Definition of rapid-fire weapons.
2. Rapid-fire gun mount assemblies.
3. Rapid-fire gun mount operation.
4. Review and summary.

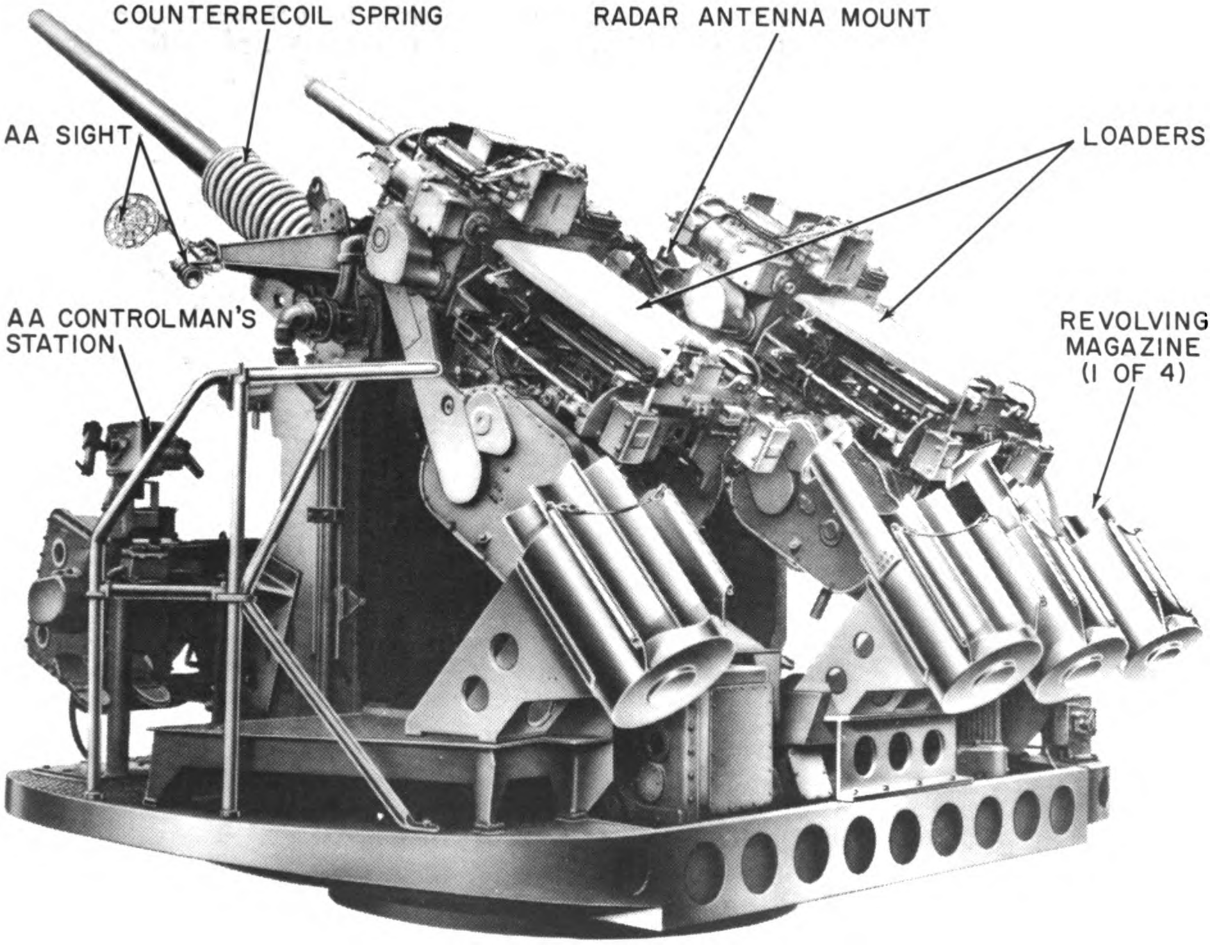
ASSIGNMENT:

A. Reference publication:

   1. Study NAVPERS 10783A, Chapter 5, pages 175 through 182.

INFORMATION AND DISCUSSION:

Our Navy, at the present, uses several types of rapid-fire weapons; the 3"/70 gun mount, the 5"/54 gun mount Mk 42, and the 8"/55 case gun turret are all of the rapid-fire type. A rapid-fire gun is classified as a gun that uses automatic power driven equipment to perform the loading operation.

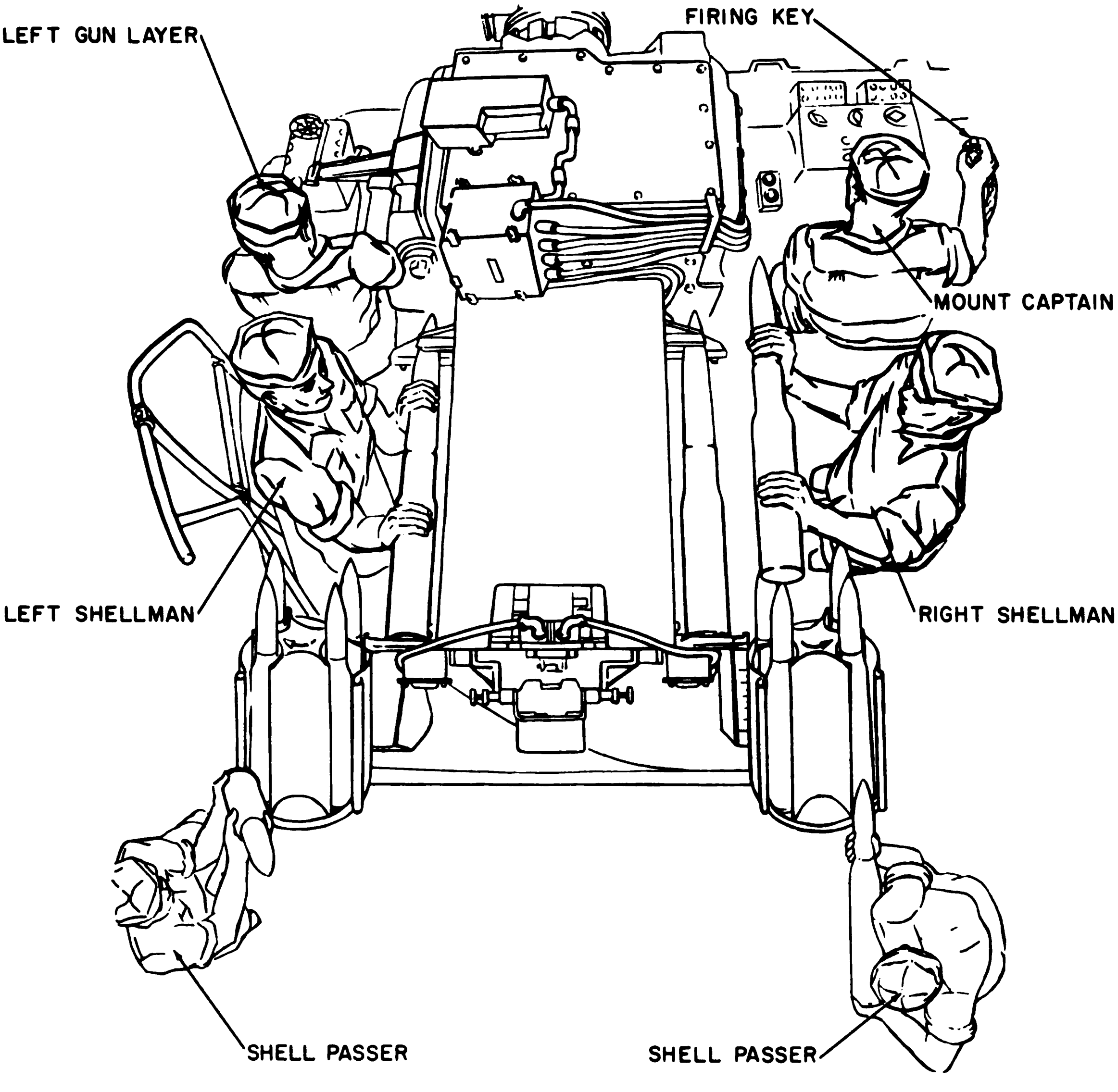


102. 3"/50 TWIN MOUNT WITH MECHANICAL LOADER

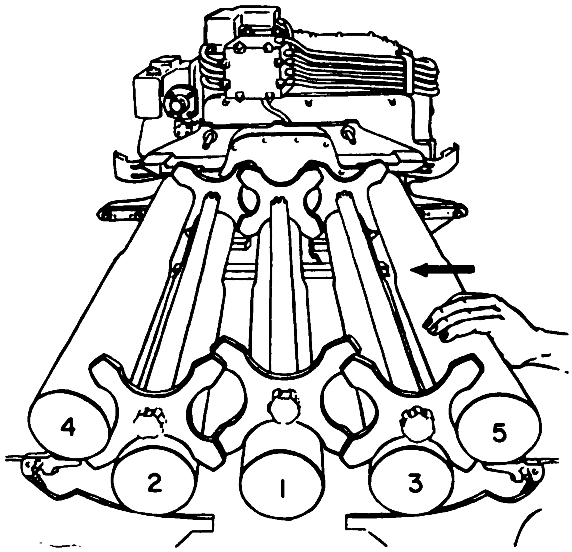
Another rapid-fire weapon is the 3"/50 gun mount which will be discussin in this topic. The 3"/50 is a gun with automatic, power driven loaders. This gun is primarily intended for defense against aircraft; however, it is also equipped for use against surface targets. The 3"/50 guns are installed in either twin or single open mounts and are designed to be used as replacements for 40 MM mounts.

The stand for the 3"/50 RF gun mount consists of a cylindrical, flanged steel casting. Its dimensions are identical with those of the 40 MM stand. Included on the stand are the training circle and stationary roller path.

The 3"/50 twin mount shown in the illustration on the facing page is interchangeable with the 40 MM quad mount. The 3"/50 single mount is similar to the 3"/50 twin mount and is designed to replace the 40 MM twin mount.



103. 3"/50 RAPID-FIRE GUN, AMMUNITION SERVICE TO LOADER



104. 3"/50 RAPID-FIRE GUN, SPROCKETS DRAWING AMMUNITION INTO THE FEED MECHANISM OF THE AUTOMATIC LOADER

The loader is an independent, electric, power driven unit, mounted on the aft part of the slide. The loader mechanically loads the gun at a rate of 45 rounds per minute in each barrel as long as ammunition is supplied.

The loader components are as follows:

1. Drive unit.
2. Hopper.
3. Transfer tray and shell carriage.
4. Control system.
5. Left side plate.
6. Right side plate.

The loader drive unit consists of a 3-horsepower motor, chains, and gear drives. The motor drives the gearing and chains which cause all mechanical parts of the loader to function at the proper time and in required sequence.

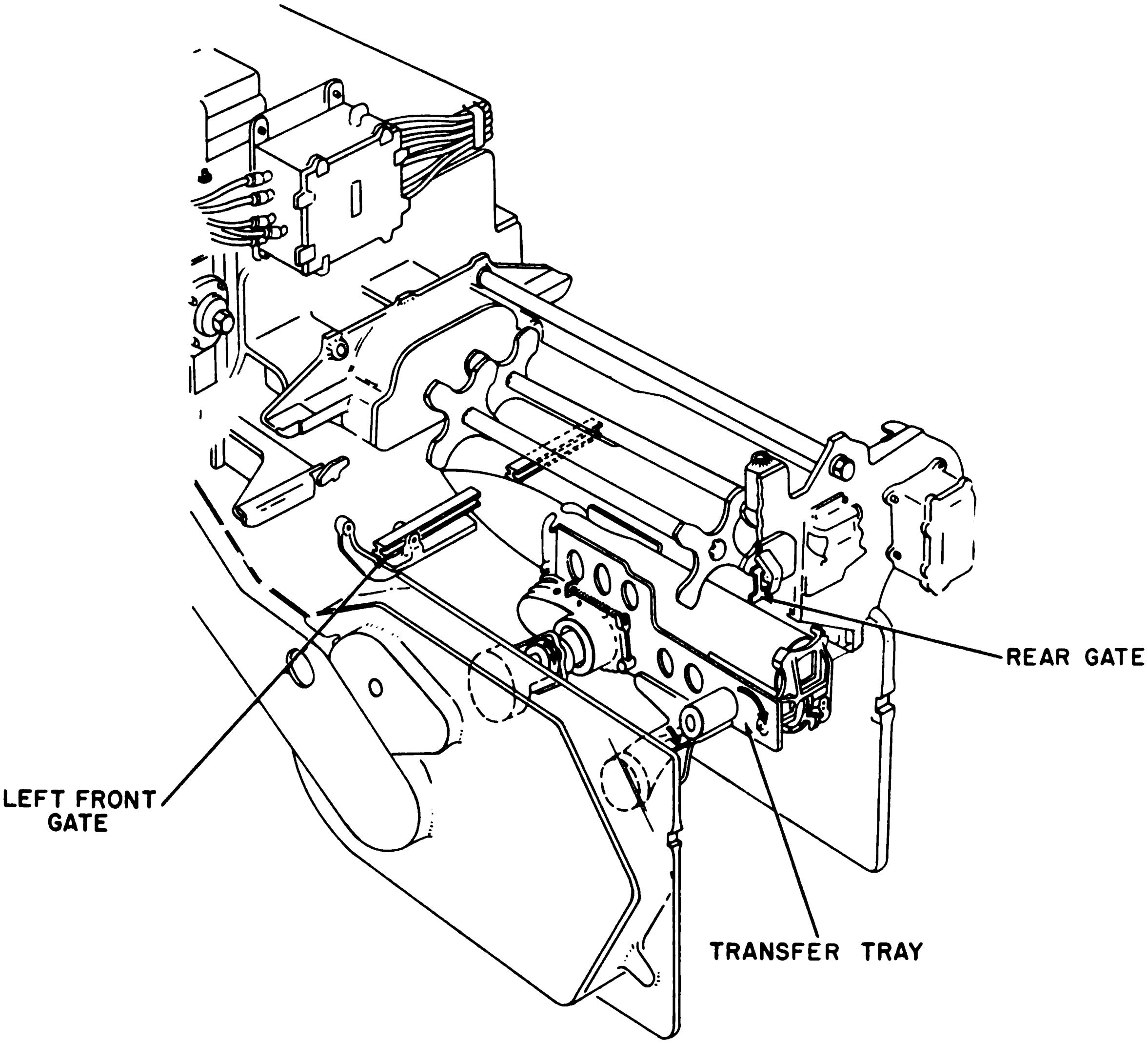
Two shellmen manually feed the ammunition into the hopper, which is located aft of the main housing and is secured to the left and right plates. (Refer to the illustration on page 163.) The hopper consists of right, center, and left shafts and their sprocket units and the right and left round alineing attachments which insure proper loading of ammunition. The right and left sprockets intermittently revolve in one direction, to move the ammunition to the center sprocket.

The center sprocket alternates direction, to accept rounds from the right and left sprockets. When the fifth round is loaded, the first round has been indexed (loaded) into the transfer tray by the center sprocket. (In the illustration in adjacent column, it is shown how ammunition is fed into the automatic loader.)

The transfer tray and shell carriage unit moves the ammunition from the index position (shown in the illustration on facing page) to the down position in line with the gun bore and catapults the ammunition into the chamber. Four arms, pivoted in the side plates, support and position the tray. The two left tray arms are driven by the transfer tray drive gears, mounted in the left side plate.

The rammer chain is driven by means of rotating shafts which extend through the left forward tray arm to the forward chain sprocket.

Secured to the rammer chain is the shell carriage (a small L-shaped casting) which supports and transports the round on the tray during the ramming cycle. When the tray reaches its most forward point, the carriage is all the way forward in relation to the tray and releases the round, which travels into the breech. (Refer to the illustration on page 166.)



105. 3"/50 RAPID-FIRE GUN, TRAY OF AUTOMATIC LOADER SWINGING DOWN INTO ALINEMENT WITH OPEN BREECH

reverses its direction of travel and moves aft and up, to pick up another round. During this reversing action of the tray, the rammer chain moves aft to position the shell carriage on the tray.

All the loader subassemblies, except the drive motor, are supported by the left and right side plates which consist of steel forgings, secured to their respective sides of the slide.

The loader control system synchronizes and interlocks the components of the loader with the breech mechanism. The system consists mainly of electrical circuits, solenoids, selector switches, automatic switches, firing keys, and electrical interlocks.

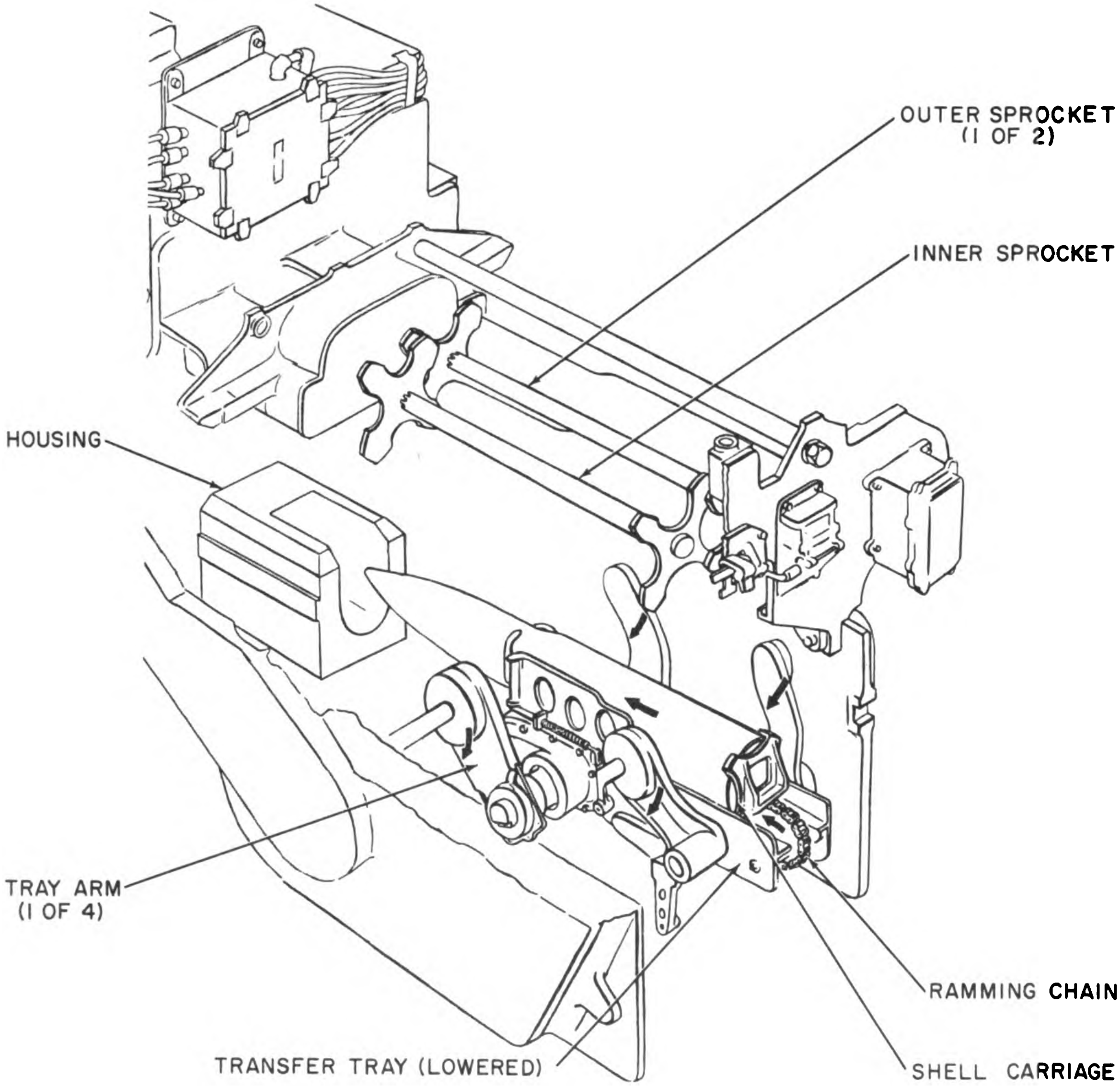
The breechblock is of the vertical sliding wedge type. As the operating shaft rotates, the breechblock is moved vertically in guideways by means of bearing blocks.

In automatic operation during counterrecoil, the breechblock is lowered and the operating spring is compressed when the operating shaft is rotated by the operating cam plate. The breech is closed by spring action.

An important part of the breech mechanism is the breech hold down mechanism (shown in the illustration on facing page) which holds the breech open until the loader completes delivery of a round of ammunition.

The extractors of the 3"/50 gun are similar to those of the 5"/38 gun, except that the inner lugs of the 3"/50 do not bear on the pallets. The extractors are free to move above the pallets, to allow automatic loading with little or no resistance to the ammunition ramming action.

On the twin mount, the mount captain's station is located between the guns. On a single mount, this station is located on the right side of the gun. The mount captain is the supervising gunner and crew captain. His operations are directed, by telephone,



106. 3"/50 RAPID-FIRE GUN, SHELL CARRIAGE CATAPULTING CARTRIDGE INTO OPEN BREECH

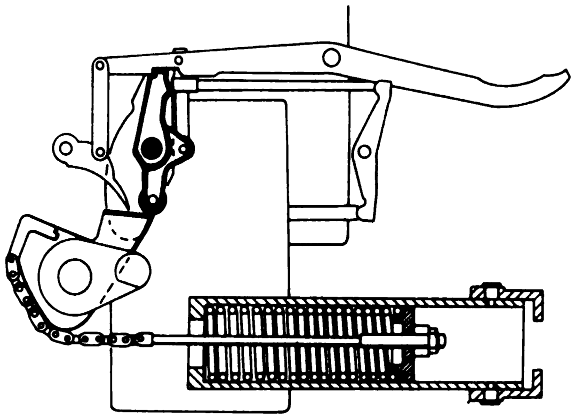
by the control officer. The mount captain controls and directs the guns by means of the mount captain's controls. In an emergency, he stops either one gun or both guns.

The gun captain's firing key must be closed before the loaders can function. The key has a latch to hold it closed if firing is controlled from the right or the left control station or from the director.

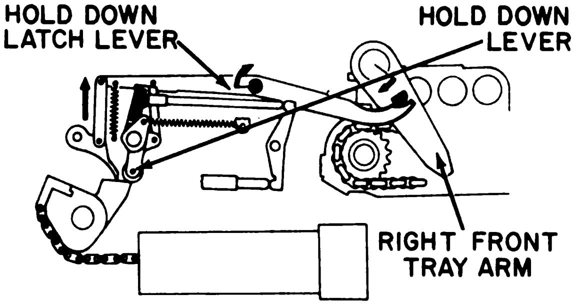
For train and elecation, the mount is equipped with amplidyne electric power drives. The train and elevation drive motors are located on the mount. The amplidyne motor generator sets and amplifiers used with the drive motors normally are located below decks.

The mount drives may be controlled either in automatic control (from a director) or in local control (from the mount). There are two local control stations: The left gun laying station is called local AA; the right gun laying station is called local surface.

When the control selector switch is set in the appropriate position, either gun laying station may control the mount in train and elevation by means of a one man control unit.



BREECH OPEN



HOLD-DOWN LATCH RELEASE ACTION, BREECH CLOSING

107. BREECH HOLD DOWN MECHANISM

QUIZ SHEET:

1. The major units of a 5"/38 carriage assembly include two of the following main components:

   a. Base ring and stand.
   b. Stand and gun carriage.
   c. Gun carriage and base ring.
   d. Base ring and gun assembly.

2. The holding down clips are bolted to one of the following mount components:

   a. Stand.
   b. Training circle.
   c. Slide.
   d. Base ring.

3. The 5"/38 gun carriage supports the gun assembly by means of trunnion bearings.

   True__________or False________.

4. 5-Inch and 6-inch guns are classified as minor caliber guns.

   True__________or False________.

5. A gun that must be loaded by hand, but, when fired, automatically opens the breech and ejects the cartridge case, is classified as being one of the following types:

   a. Single fire.
   b. Semiautomatic.
   c. Automatic.
   d. Rapid-fire.

6. The gun bore extends from the forward end of the gun chamber to the muzzle.

   True__________or False________.

7. All Navy guns, except the .45 caliber pistol, have left-hand twist rifling.

   True__________or False________.

8. The interrupted screw plug type breechplug is used only on one of the following types of guns:

   a. Bag guns.
   b. Case guns.
   c. Small arms.
   d. Machineguns.

9. The 5"/54 gun has a longer barrel than the 5"/38 gun.

   True__________or False________.

10. The 5"/38 counterrecoil system helps the recoil system to stop the rearward movement of the gun after firing.

    True__________or False________.

11. Which one of the following 5"/38 breech mechanism components holds the breechblock in the down position?

    a. Extractor.
    b. Salvo latch.
    c. Breechblock operating spring.
    d. Extractor plunger.

12. The rate of fire per barrel of a 3"/50 RF gun mount is:

    a. 30 rounds per minute.
    b. 15 rounds per minute.
    c. 45 rounds per minute.
    d. 20 rounds per minute.

13. The transfer tray drive gears for the automatic loader on the 3"/50 RF gun are mounted on one of the following:

    a. Right forward tray arm.
    b. Shell carriage.
    c. Right side plate.
    d. Left side plate.

14. On the 3"/50 RF gun, the breech is locked open by one of the following components:

    a. Pallet inner lug.
    b. Pallet outer lug.
    c. Hold down mechanism.
    d. Operating spring.

Accuracy of notes checked by instructor:

Date______________________________

Trainee's initials____________________

TOPIC 5: AMMUNITION HOISTS

You Are Now Going to Learn:

1. Use, types, and basic construction features of ammunition hoists.
2. Function, general arrangement, and operation of the 5"/38 projectile hoist.
3. Function, general arrangement, and operation of the 5"/38 upper powder hoist.
4. General arrangement and construction features of the Vickers Dredger hoist.

You Will Acquire Skill in:

1. Operating the 5"/38 projectile and powder hoists.
2. Operating the dredger hoists.

Discussion Points for this Topic Are:

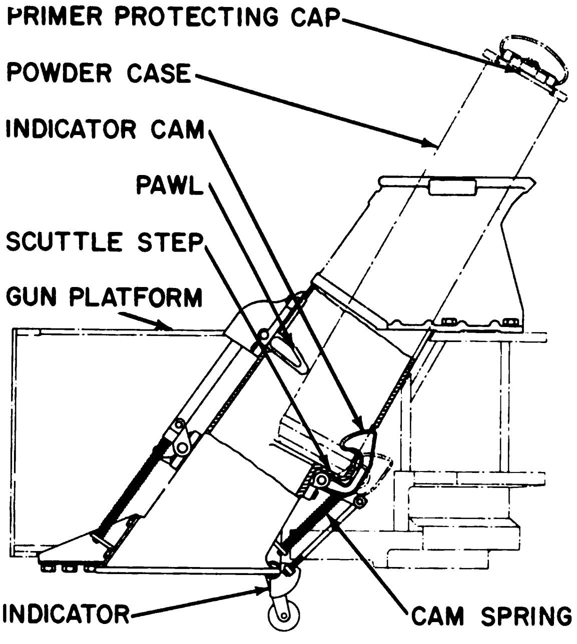
1. Purpose of ammunition hoists.
2. Typical gun mount hoists.
3. Bureau cognizance of hoists.
4. Introduction to the 5"/38 upper projectile hoist.
5. Function and general arrangement of hoist main components.
6. Introduction to the 5"/38 upper powder hoist.
7. General arrangement and functions of hoist main components.
8. Introduction to the Vickers Dredger hoist.
9. General arrangement and construction features of the hoist trunk.
10. Review and summary.

INFORMATION AND DISCUSSION:

Ammunition hoists function to supply the guns and ready service rooms with ammunition for the ship magazines. These hoists may also provide a means of loading and off-loading ammunition.

Ammunition hoists are often described by the way they are constructed. For example, 5"/38 caliber gun hoists may be referred to as endless chain hoists because the hoist chain ends are joined and operate over two sprockets, one located at each end of the hoist tube. Another example of hoists described by their construction features is the wire rope (cable) hoists used for powder bags in turrets.

In gun mounts and turrets where a handling room is located between the magazine



108. POWDER SCUTTLE (5"/38 SINGLE MOUNT)

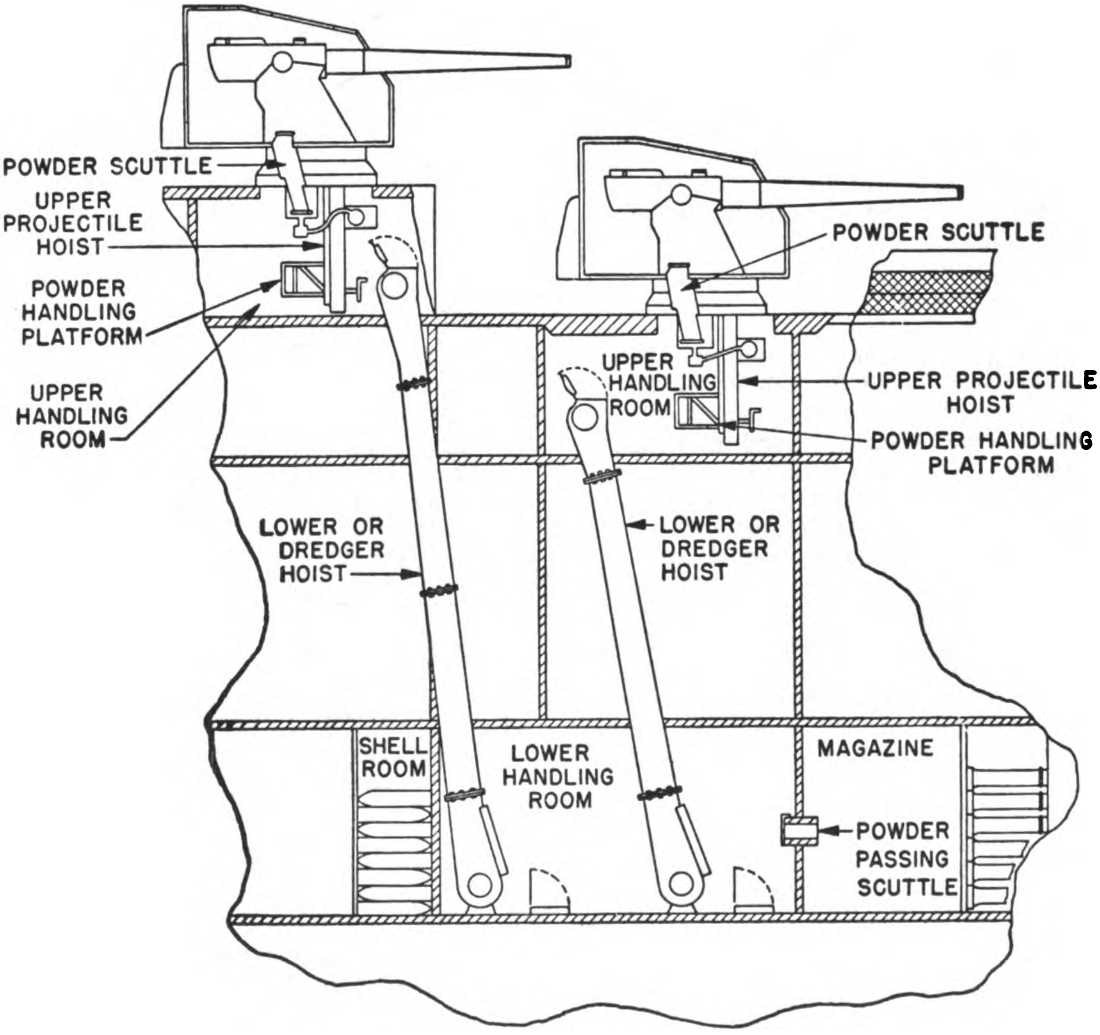
and gun, the hoists may be referred to as lower and upper hoists or as first stage and second stage hoists.

Gun mount ammunition hoist arrangement varies with the type of ship and gun. A typical destroyer 5"/38 single mount installation is shown in the illustration on the facing page. In this setup, a lower (dredger) hoist supplies both powder and projectiles to an upper handling room, located directly below the gun mount.

Dredger hoists are one stage, endless chain, conveyor type hoists. All dredger hoists are similar in construction, except for differences in the power drive and its control. Power drives for dredger hoists have been manufactured by Waterbury Tool Company, Northern Pump Company, and Vickers, Inc.

In the 5"/38 single mount, and electro-hydraulically operated, endless chain hoist performs the dual task of lifting projectiles from the upper handling room to the gun room and simultaneously sets a time fuze (if a time fuzed projectile is used). The powder charges in a 5"/38 single mount are manually passed into the gun room through a powder scuttle, as illustrated below.

The ammunition supply arrangement for a 5"/38 twin mount is similar to that of the



109. TYPICAL 5"/38 SINGLE MOUNT HOIST ARRANGEMENT

single mount, except that two upper projectile hoists are used instead of one, as shown in the accompaning illustration, and that two endless chain, electro-hydraulically operated upper powder hoists are used in place of the powder scuttle. Dredger hoist power drives used with twin mounts, like those used in single mounts, may be made by any of three manufacturers, but they are usually made by Vickers, Inc.

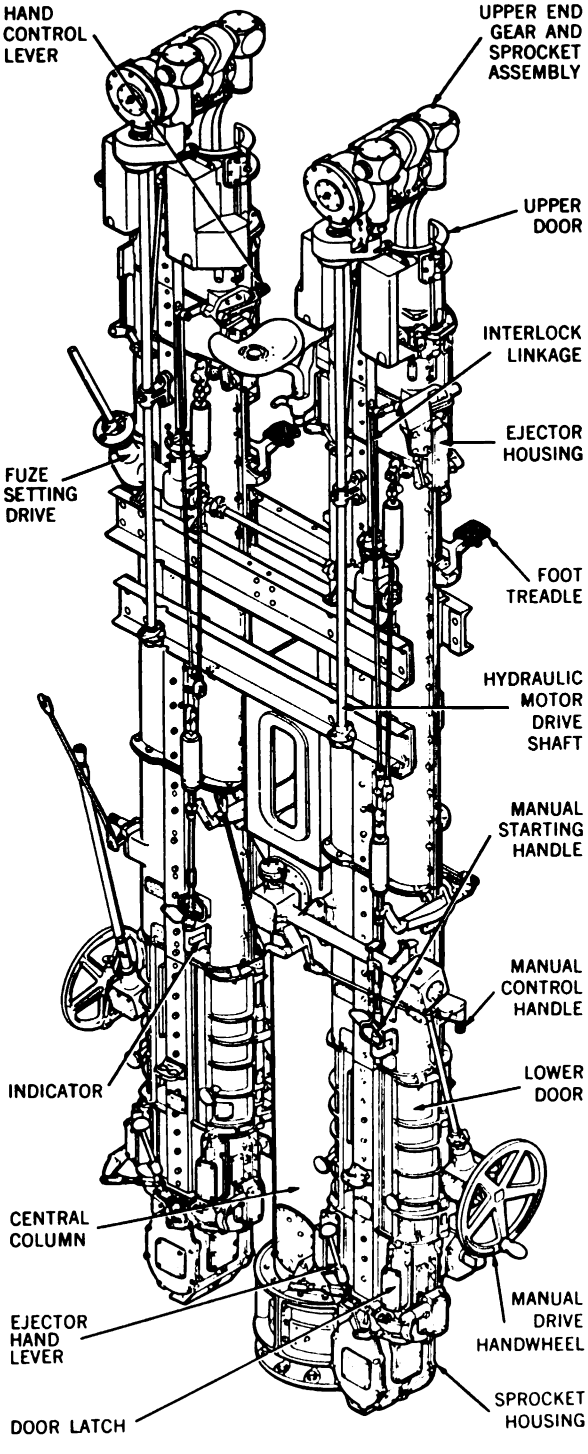
The 3"/50 rapid-fire mounts are not located over ready service rooms like the 5"/38 mounts. However, ready service ammunition is stowed in rooms usually located on the main deck or the 01-level in the general vicinity of the gun mount. One ready service room may supply several gun mounts.

On some ships, an endless chain, conveyor type dredger hoist is used to supply the 3"/50 RF ready service room with ammunition from the magazine. The upper end of this type of hoist is located either in or near the ready service room. The power drive for the 3"/50 dredger hoist is manufactured by Vickers, Inc.; however, it differs from the Vickers power drive used with the 5"/38 dredger hoist.

The responsibility for ammunition hoists is divided between BUWEPS and BUSHIPS. This means that the information on hoists assigned to BUWEPS can be found in the applicable OP's, OD's, and BUWEPS drawings. These publications are in the custody of the shipboard weapons department and are readily accessible to the gunner's mates.

However, information on the hoists assigned to BUSHIPS is contained in NAVSHIPS publications and drawings. These NAVSHIPS publications and drawings are assigned to the shipboard engineering department and can be obtained in the log room.

BUWEPS is responsible for all automatic gun mount loading system hoists, such as the 5"/54 RF hoists, and for all other hoists on nonautomatic gun mounts that are attached to and rotate with the gun mount.



110. 5" PROJECTILE HOISTS, GENERAL ARRANGEMENT

Gun mount ammunition hoists that interconnect the magazine and ready service room, such as the 5-inch and 3-inch lower (dredger) hoists, are under the cognizance of BUSHIPS.

Two upper powder hoists, one for each gun, supply powder cases to the guns of a 5"/38 twin mount. These endless roller chain type hoists are enclosed in tubes. Each hoist has a semiautomatic electro-hydraulic power drive, control unit, and an auxiliary hand drive. In many respects, the corresponding components of the powder and projectile hoists are similar.

The powder hoist tubes are mounted to the rear of the projectile hoist tubes and the upper sections curved toward the rear of the mount. The tubes are suspended from channel supports secured to the base ring and are also braced and supported by the central column.

Each hoist tube has two doors at its lower end through which the powder case is loaded into the hoist and an opening at its upper end through which the powder case is unloaded.

The hoist chain is located in guideways in the hoist tube and rides over sprockets at the upper and lower ends of the hoist. Attached to the chain are evenly spaced flight assemblies which support the inverted powder case during hoisting and lowering. The upper sprocket is the drive sprocket and the lower sprocket is an idler sprocket through which chain tension can be adjusted.

Hoist controls consist of lower end control gear cam assembly, door interlock, control gear interlock, and upper end cam assembly. The control gear door interlock extends from the lower to the upper end of the hoist and is mounted on the inboard side of the tube.

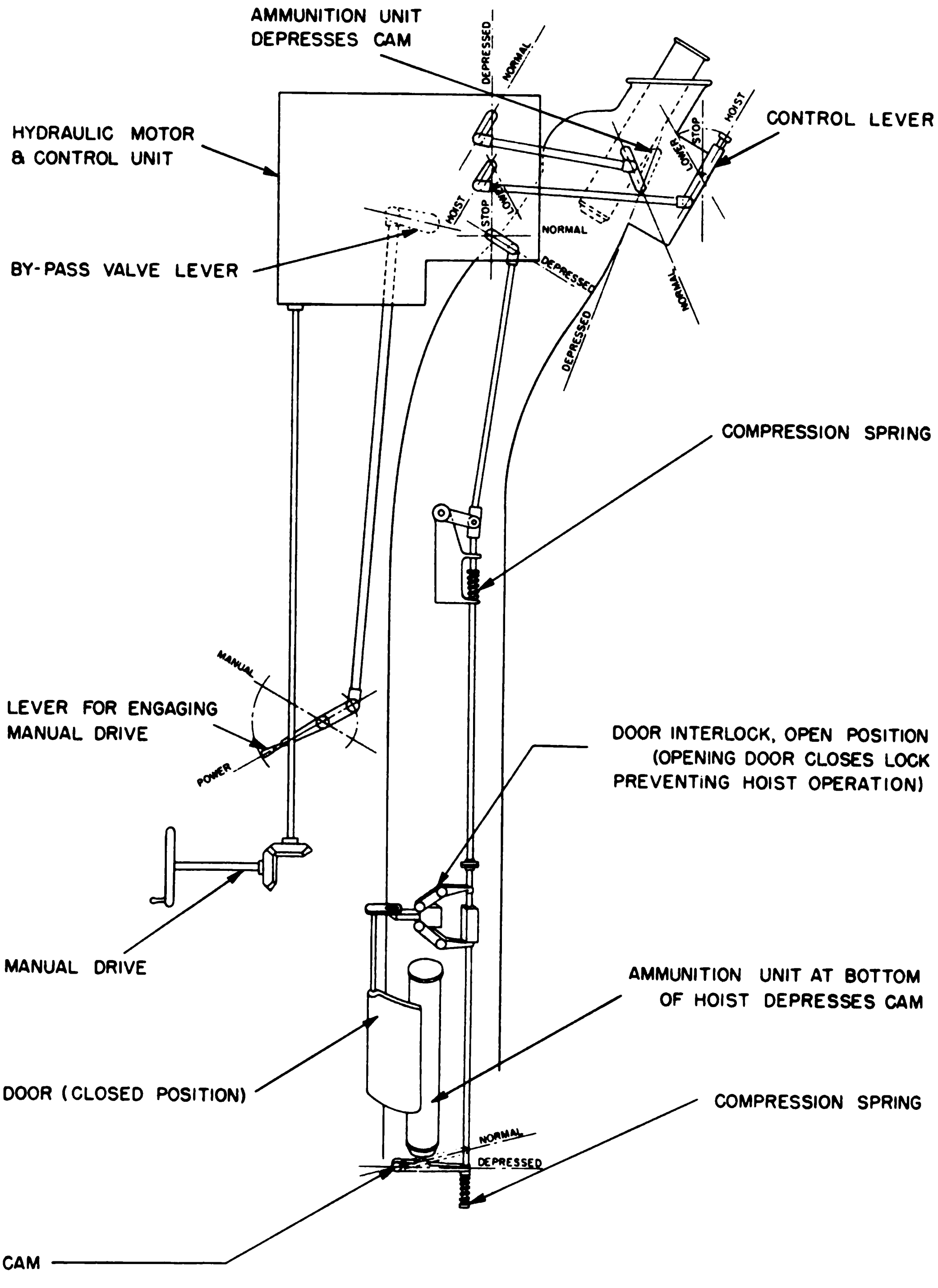
During normal operation, the hoist power drive and controls operate together to deliver powder cases to the guns. Loading of a powder case into the receiving end of the hoist starts hoist movement. Arrival of the case at the delivery end automatically stops hoist movement. A cycle will take place only when the receiving end of the hoist is loaded and the delivery end is empty. Direction of chain movement is the same for successive cycles: however, when reversing valve C is shifted from HOIST to LOWER or from LOWER to HOIST the direction of chain movement is reversed.

The 5"/38 twin mount powder hoist installation is driven by two complete, independent power drives, one for each hoist. Each drive consists of a power unit and a hoist drive unit.

The hoist power units are mounted to the rear of the base ring beneath the mount captain's platform. The power unit consists of an electric motor, a projectile hoist pump, a powder hoist pump, and a tank. The power unit serves the powder and projectile hoists. The smaller of the two pumps is the powder hoist pump. A relief valve and an auxiliary relief valve are mounted in the same valve block as the relief valves for the projectile hoist.

The hoist drive units are mounted near the upper ends of the hoists and are connected directly to the upper sprockets of their respective hoists. Each drive unit consists of a hydraulic motor and a valve block which contains timing cams and valves to control the action of the hydraulic motor. The drive unit also includes an auxiliary hydraulic brake and a hand drive mechanism, which are similar in construction and operation to those in the projectile hoist. The hoist drive unit of the powder hoist drive is functionally similar to that of the projectile hoist power drive; however, the shape and valve arrangement of the valve block differ from those of the projectile hoist power drive. (The illustration on the following page is a schematic diagram of a 5-inch powder hoist.)

The Vickers dredger hoist, like other 5"/38 dredger hoists, is an electro-hydraulic, endless chain, lower ammunition hoist that is used to transfer powder cases (in tanks) and projectiles (with fuze caps) from the magazine to the upper handling room. The projectiles and powder tanks may be transferred in any ratio. During wartime conditions, common practice is to alternately hoist powder tanks and projectiles, to provide an adequate supply of complete rounds. The


AMMUNITION UNIT DEPRESSES CAM
DEPRESSED
NORMAL
HYDRAULIC MOTOR & CONTROL UNIT
CONTROL LEVER
HOIST
STOP
LOWER
NORMAL
BY-PASS VALVE LEVER
DEPRESSED
DEPRESSED
NORMAL
COMPRESSION SPRING
MANUAL
LEVER FOR ENGAGING MANUAL DRIVE
POWER
DOOR INTERLOCK, OPEN POSITION (OPENING DOOR CLOSES LOCK PREVENTING HOIST OPERATION)
MANUAL DRIVE
AMMUNITION UNIT AT BOTTOM OF HOIST DEPRESSES CAM
DOOR (CLOSED POSITION)
COMPRESSION SPRING
NORMAL
DEPRESSED
CAM

111. 5" POWDER HOIST, HYDRAULIC CONTROL, SCHEMATIC DIAGRAM

lower end of the hoist is located in a handling space, convenient to the powder and projectile magazines. The upper end of the hoist is located in or near the upper handling room. The dredger hoist installation for two 5"/38 single mounts aboard a destroyer is shown in the illustration on the facing page.

The Vickers dredger hoist can be divided into the following three major units:

1. Hoist trunk - includes the chain, sprockets, and upper and lower interlock cams.

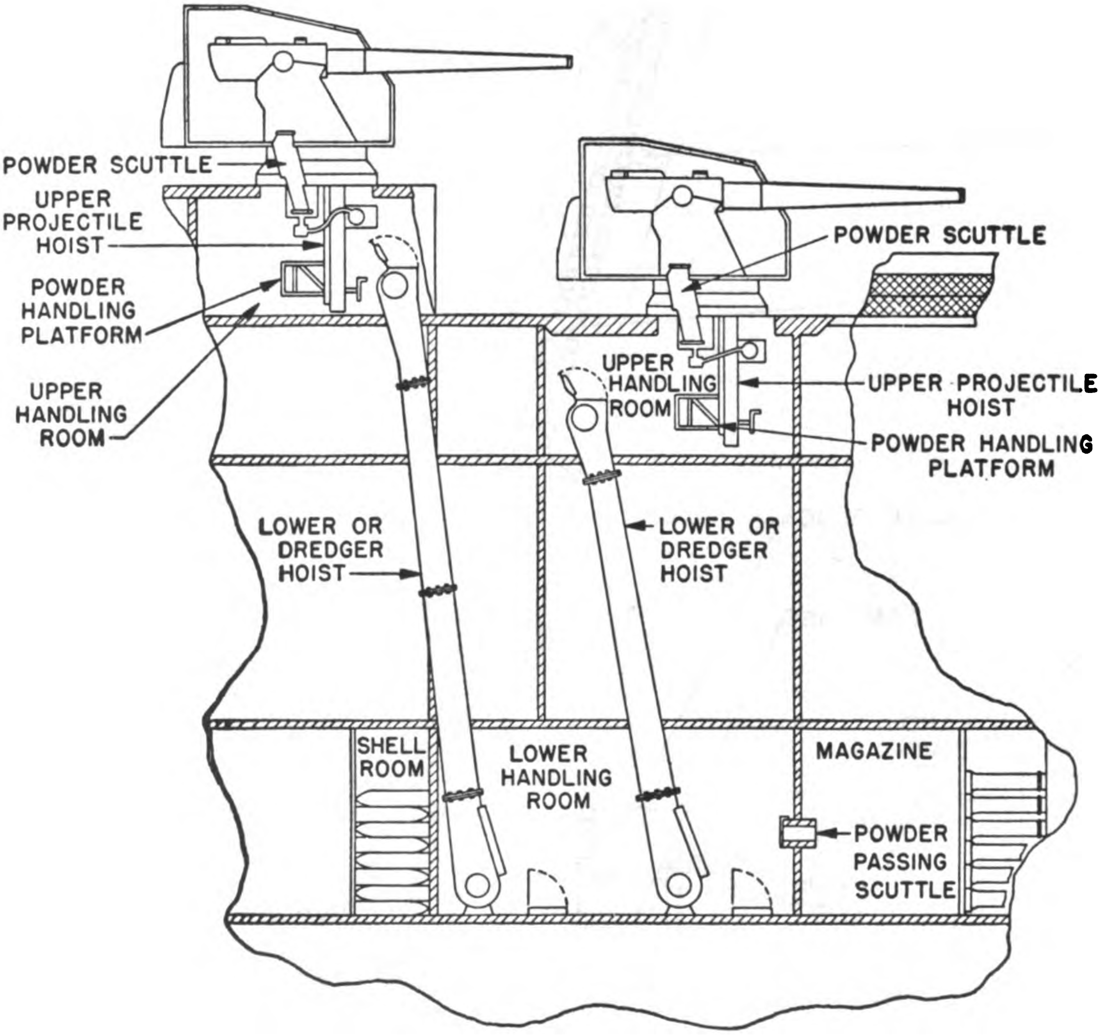
2. Power supply unit - includes the electric motor, hydraulic pump (A-end), tank, and hand pump.

3. Control drive unit - includes the valve block, cam case, and hydraulic motor (B-end).

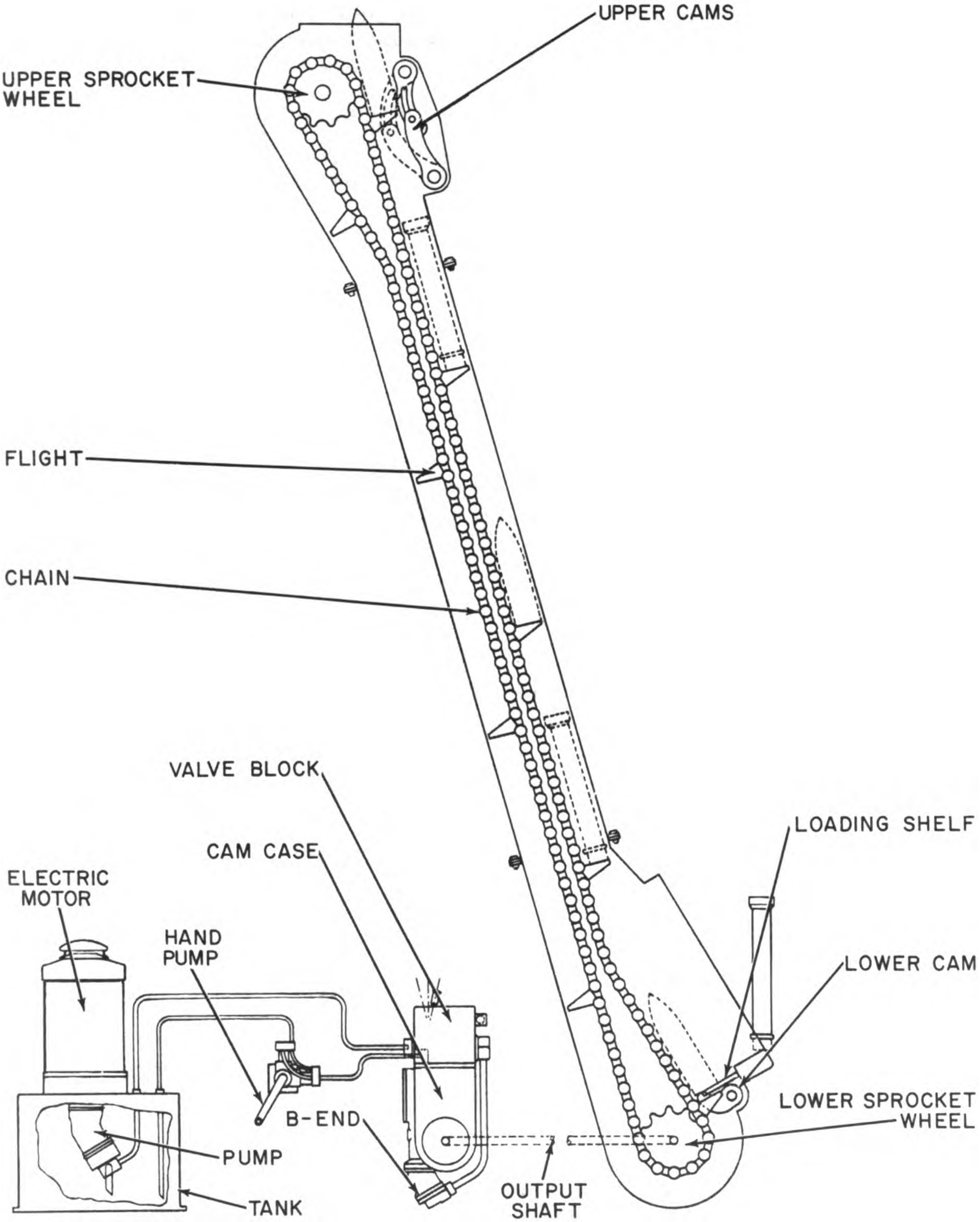
The three main hoist units are shown schematically in the illustration on the following page.

The hoist trunk (tube) consists of an upper, an intermediate, and a lower section. These three sections are bolted together to form a watertight enclosure.

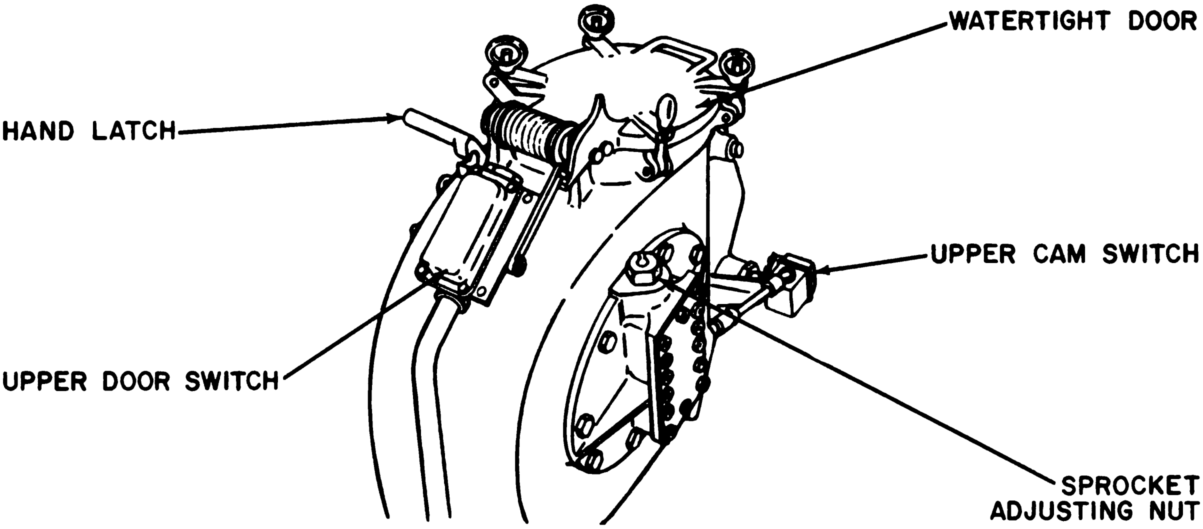
The hoist upper section (upper casing) provides a housing to support the upper chain sprockets and also provides an opening for loading and unloading ammunition. When



112. TYPICAL DREDGER HOIST INSTALLATION



113. VICKER'S DREDGER HOIST, SCHEMATIC



114. DREDGER HOIST, UPPER CASING

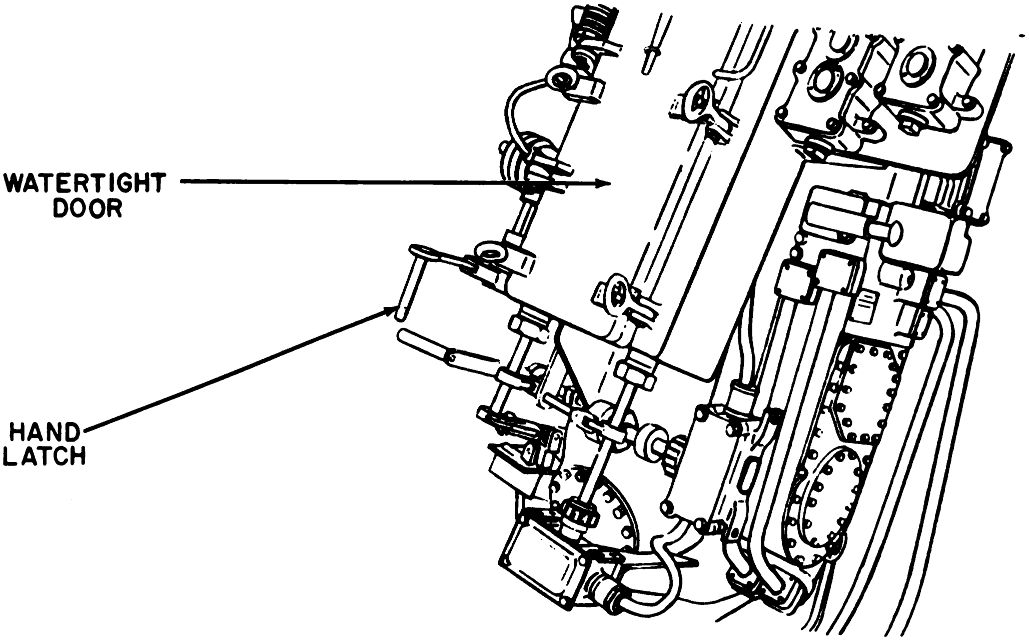
dogged down, a door seals the opening, as shown in the illustration above. The door is spring loaded to the closed position and is held open by a hand operated latch.

When the upper door is closed, it actuates an upper door switch which opens the start and run circuit to the electric drive motor. This switch prevents a unit of ammunition from being hoisted into a closed upper door.

A set of cams, shown in the illustration on facing page, is located in the upper cassing and is actuated by a unit of ammunition as it approaches the upper station. These cams are also actuated when a unit of ammunition is loaded into the upper station for lowering. The cams, through linkage, actuate the upper cam switch. The switch is in a solenoid circuit that prevents hoisting unless the upper station is empty.

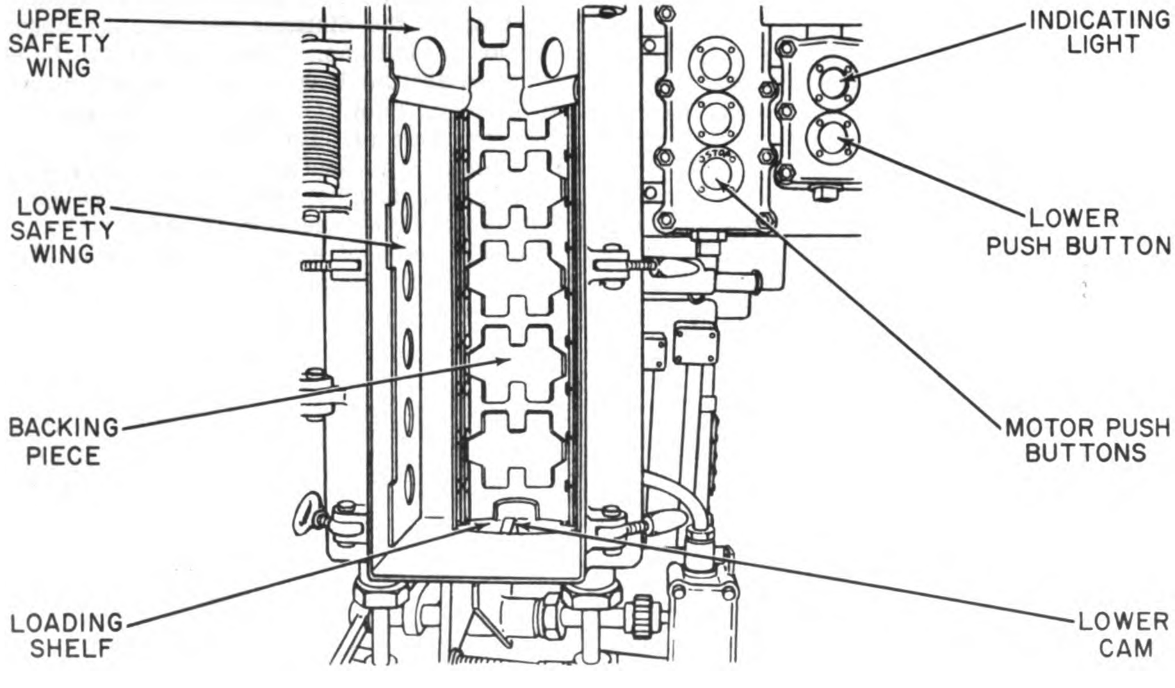
Two idling sprockets are also mounted in the upper section casing. These sprockets support the weight of the chain and ammunition units. The idling sprockets can be raised or lowered by adjusting nuts, one of which is shown in the illustration above, to change the hoist chain tension.

The intermediate section of the dredger hoist spans the distance between the upper and lower stations. This part of the hoist is normally the longest and may be made up of more than one section, depending upon the type of ship and the location of the hoist. The sections are sometimes curved and may be mounted at an angle. The intermediate section is primarily a tube with channel shaped guide tracks for support of the hoist chain.

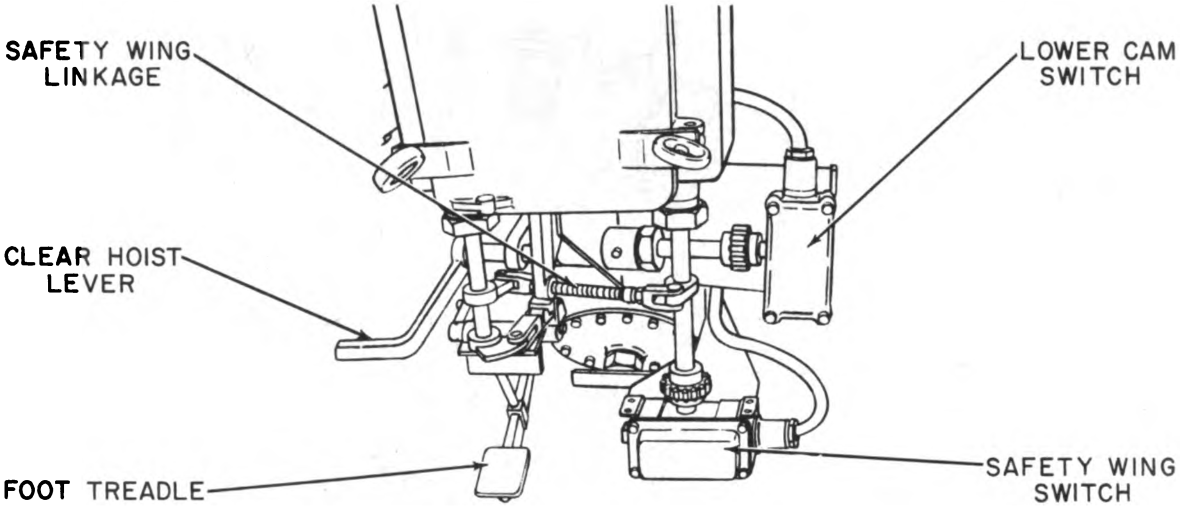


115. DREDGER HOIST, LOWER CASING

The hoist lower section (lower casing, illustrated above) provides a housing to support the lower (drive) sprocket and also provides an opening which serves as a loading and unloading station. Like the upper opening, the lower opening has a door that is watertight when dogged down. It is spring loaded to the closed position and held open



116. LOWER CASING, DOOR OPEN



117. LOWER CASING, EXTERNAL LINKAGE, LEVERS, AND SWITCHES

by a hand operated latch. However, the lower door does not actuate an interlock switch as the upper door does.

Safety wings, mounted under the lower casing door, prevent a hoisting or lowering cycle from starting while ammunition units are being passed through the hoist lower opening. The safety wings are perforrated metal flaps mounted in two sets, one above the other, with the upper set overlapping the lower set. The lower set may be moved inward (depressed) independently of the upper set, but when the upper set is depressed, the lower set is also depressed.

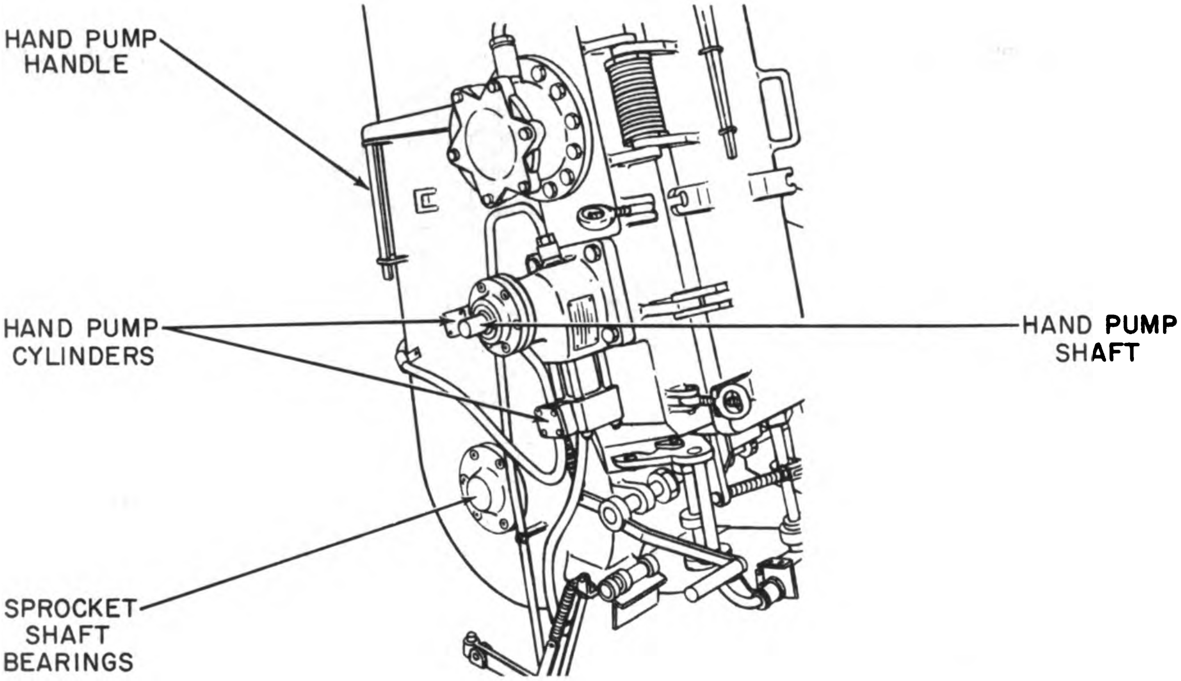
The lower set of safety wings may be depressed by a foot treadle, shown in the illustration at the bottom of facing page, allowing the operator to use both hands for handling ammunition units. Both sets of safety wings can be depressed by means of a hand lever located above the hoist lower door. Linkage from the safety wings actuates an interlock switch which opens the circuit to a solenoid whenever the safety wings are depressed.

A cam is mounted in the lower casing so that it is actuated by a unit of ammunition at the lower station. The cam is linked to a double throw switch, as illustrated above, in the solenoid circuit. The switch and solenoid are wires so that, when the lower cam is actuated by a unit of ammunition and all controls are set up for hoisting, the solenoid energizes to start a hoisting cycle. However, when the hoist is lowering, cam actuation causes the solenoid to deenergize, stopping the hoist. The lower cam can also be manually actuated by a CLEAR HOIST lever that allows the hoist to cycle in the hoisting direction without units of ammunition being placed in the lower casing.

The two driving sprockets, located in the lower casing, provide the rotary motion required to drive the hoist chain. These non-adjustable sprockets are keyed to a common shaft, which is driven through a worm and worm gear by the hydraulic motor.

The hoist chain assembly consists of two roller type, endless chains connected by backing pieces (refer to the illustration at the bottom of facing page) to form an endless metal belt. Two fingered pawls (called flights) are mounted at right angles to the chain and are evenly spaced throughout its entire length. These flights support the unit of ammunition during hoist movement.

The power supply unit consists of both a hand and a motor driven hydraulic pump.



118. HAND PUMP UNIT

The hand pump unit, shown in the illustration above, is mounted to the lower casing and serves as an auxiliary means of operating the hoist in the event of electrical power failure. This pump is of the dual piston, double action, reciprocating type that is capable of delivering a constant flow of oil to the control unit for hoist operation.

The motor driven power unit consists of an electric motor, pump (A-end), tank, and filter, mounted as a unit separate from, but near, the hoist lower casing.

The 7-1/2 HP electric motor, mounted on top of the supply tank, drives the A-end at a 1 : 1 ratio. The A-end is a standard Vickers, parallel piston, fixed tilt pump that has a displacement of approximately 13. 5 gpm.

The square supply tank has a capacity of approximately 20 gallons and is fitted with an oil level gauge, a strainer, an air vent, and a float device which prevents oil from spilling when surges occur. Also mounted to the tank is a filter unit that cleans the hydraulic fluid as it leaves the A-end. If the filter becomes clogged, a check type relief valve in the filter bypasses pump output.

Two projectile hoists, one for each gun, supply projectiles to the guns of a 5"/38 twin mount. These endless roller chain type hoists are enclosed in tubes. Each hoist has a semiautomatic electro-hydraulic power drive, a control unit, and an auxiliary hand drive.

One fuze setting indicator regulator controls the fuze setting for both hoists. Projectile nose fuzes are automatically set as the projectiles are hoisted.

The hoists are located inboard, between the two gun carriages. The hoistways, flange bolted assemblies of bronze sections, are suspended from channel supports between girders which are attached to the base ring. Their upper ends extend approximately 6 feet above the mount floor. Their lower ends extend down into the handling room, nearly to the deck. Both hoists are braced and supported by the central column.

Each hoistway consists of two tubes which are fitted with triple chain drives. Each tube is grooved to form three guideways for the chains. Three endless chains run through these tubes and over sprockets at the upper and lower ends of the hoistway. The drive sprockets are at the upper end of the hoistway.

The center chain is the hoisting chain, and attached to it are two sockets, or fuze pots. The sockets are so arranged on the chain that while a projectile is being hoisted in one tube, the empty socket is being lowered in the other tube. During normal operation, when a projectile is placed in a socket at the lower station, the hoist automatically cycles, provided that the socket at the upper station is empty.

The two outer chains are the fuze setting chains and are driven by the fuze setting indicator regulator. Each chain controls the fuze setting of the projectile carried in one of the fuze pots on the hoist chain.

Manual control at the lower station allows for selection of power or manual drive, emergency stopping of the hoist, and ejection of projectiles from the sockets. The only manual control at the upper station is a foot operated ejector mechanism for removing the projectile from the socket in preparation for loading the gun.

The hoist power unit consists of an electric motor, hydraulic pump, and tank. The power unit supplies both operating and control pressure to the hoist drive unit and receives the return flow from the drive unit.

The hoist drive unit consists of a hydraulic motor, valve block, timing mechanism, and hand drive unit. The hydraulic motor, which supplies power to drive the hoist, operates intermittently under control of the valve block and timing mechanism. A hydraulic brake and hand drive unit prevent the hoist from being driven backward by the weight of the projectile if power is cut off and make it possible to drive the hoist manually in case of power failure and for servicing purposes. With a pair of cams and linkage connected to the hoist, the drive unit controls starting, acceleration, full speed, length of stroke, deceleration, and stopping of the hoist.

Projectiles are delivered to the guns through paired hoistways in the hoist tubes; the hoists reverse direction in alternate cycles.

Only the center sprocket is part of the hoistway proper. (The forward and rear sprockets are parts of the fuze setting mechanism.) The center sprocket is splined to a drive shaft, which receives its power from the hydraulic motor through a pair of bevel gears that transmit motor rotation to the hoist chain through the upper sprocket. The lower hoistway sprocket is a bearing mounted idler sprocket. Hoist chain tension is adjusted through an adjusting screw to the idler sprocket.

TOPIC 6: PLANNED MAINTENANCE SYSTEM

You Are Now Going to Learn:

1. Purpose, benefits and terminology of the Navy Planned Maintenance System.
2. Tools of the planned maintenance system.

You Will Acquire Skill in:

1. Maintenance and lubrication of the 5"/38 and 3"/50 gun mounts and ammunition hoists.

Discussion Points for this Topic Are:

1. Objectives and benefits of the planned maintenance system.
2. Planned maintenance system manual.
3. Cycle schedule of the planned maintenance program.
4. Control Board.
5. Maintenance Requirement Cards.
6. Review and summary.
7. Section review.
8. Written test.

ASSIGNMENT:

A. Reference publication:

1. Study OPNAV 43P1, Chapters 1 and 2, pages 1 through 10.

INFORMATION AND DISCUSSION:

The discussion points for this topic are thoroughly covered in this assignment.

PERFORM THE FOLLOWING OPERATIONS:

1. Hold PM and lubrication as required on 5"/38 and 3"/50 gun mounts and 5"/38 power and projectile hoists.
2. Hold PM and lubrication as required on the dredger hoists.

Section 9

MISSILE LAUNCHING SYSTEMS

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Introduction to a Typical Missile Weapon System	184
2.	Introduction to GMLS Mk 10 Mod 0	188
3.	Missile Magazine Components	192
4.	Launcher Loader and Loader Components	198
5.	Launcher Guide Arm Components	202
6.	Launcher Mk 5	204
7.	Dud Jettison Assembly	208
8.	Launching System Control Mk 8 Mod 0	212
9.	Missile Replenishment and Strikedown	218
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TOPIC 1: INTRODUCTION TO A TYPICAL MISSILE WEAPON SYSTEM

You Are Now Going to Learn:

1. Major components of a typical missile weapon system.

2. Definitions of terms.

Discussion Points for this Topic Are:

1. Purpose of a missile weapon system.

2. Guided missile launching system:

    a. Feeder system.
    b. Launcher.
    c. Launching system control.

3. Weapons control system.

4. Definitions of terms.

5. Review and summary.

INFORMATION AND DISCUSSION:

The purpose of a missile weapon system is to deliver a weapon to destroy the target. A typical missile weapon system consists of the following major units:

1. Guided missile launching system (GMLS).

2. Weapons control system (WCS).

The purpose of a guided missile launching system is to deliver a missile, ready for firing, from the missile magazine to the launcher guide arm. The launching system must also be capable of returning a missile from the launcher guide arm to the magazine for stowage.

The delivery of weapons to the launcher may be either continuous or intermittent (as needed), and weapons may be fired in salvos or individually, in accordance with the demand of the tactical situation.

The launching system can be operated in automatic or step control. To transmit a missile from the magazine to the launcher in automatic control, it is necessary only to properly position switches on applicable control panels. In step control, each unit of equipment that transmits a missile must be actuated by a pushbutton control.

Provisions are made on each missile launching system to load (strikedown) and assemble (mate) missile and booster and to stow the mated weapon in the magazine.

Guided missile launching systems can usually be divided into the following main units:

1. Feeder system.

2. Launcher.

3. Launching system control.

The feeder system stores missiles and delivers them to the launcher. A typical feeder system consists of the following major units:

1. Magazine.

2. Loader.

3. Assembler.

4. Strikedown and checkout equipment.

NOTE: Not all missile launching systems have the type of feeder system described above. For example, Tartar missile launching systems have no assemblers. (In other launching systems the loader is referred to as rammer.)

The feeder system is usually made up of duplicate components, one set of which is called A-side, the other B-side. (When the launching system is viewed from the aft end, A-side is to the left.) Each side is capable of transmitting missile/booster combinations to the launcher simultaneously with the other side or independently.

When the feeder system includes an assembler, a part of the feeder system is designated as the assembly area. This area is often located near the launcher and is used for assembly of wings and fins to the missile.

NOTE: Feeder systems of Terrier and Talos missiles include an assembler.

The missile launcher supports the missile and points it in the direction designated by the missile fire control system. The launcher also performs the following functions necessary for proper missile operation:

1. Missile warmup.
2. Missile arming.
3. Missile firing.
4. Prevents missile departure from the guide arm until enough thrust for flight has been developed.

The launching system control includes all control panels, power panels, test panels, control circuit wiring, relays, and switches necessary for operation of the guided missile launching system.

A typical weapons control system (WCS) aboard ship includes all the equipment necessary to control target assignment to either guns, missiles, or ASW weapons, in accordance with tactical requirements. A weapons control system includes the following:

1. Weapons direction system (WDS).
2. Missile fire control system (MFCS).
3. Gun fire control system (GFCS).
4. Underwater battery fire control system (UBFC).

NOTE: Some ships do not have all these systems.

The weapons direction system coordinates and monitors the operations of the missile launching system and the fire control systems.

Some of the major tasks performed by the weapons direction equipment (WDE) are listed below:

1. Director to target assignment.
2. Launcher to director assignment.
3. Salvo select.
4. Missile warmup.
5. Missile firing.
6. Emergency and dud firing.

Missile fire control systems include directors, radars, and computers. These units perform the following major functions:

1. Tracking of designated target.
2. Transmission of target data to WDS.
3. Aiming of launcher.
4. Guidance of missile to target.

Before proceeding to the GMLS Mk 10, terms applying to missiles and missile launching systems should be understood. A list of such terms follows.

AERODYNAMIC CONTROL SURFACES: Wings and fins for controlling missile flight.

AFT BOOSTER SHOES: Two T-shaped lugs used for handling the weapon.

BEAM RIDER: Missile whose flight is electronically controlled to steer a base course with reference to center of a radar beam.

BIRD: Slang term for the missile.

BOOSTER: Solid fuel propelling charge, used to accelerate the missile to flight speed.

INTRODUCTION TO A TYPICAL MISSILE WEAPON SYSTEM

BW: Beam riding, wing controlled missile.

CAPTURE PHASE: Phase of missile flight during which missile is under electronic control of the radar capture beam.

CG: Marking found on missiles, boosters, and assembled missile/booster combinations to indicate the center of gravity.

CHECKOUT: Preflight checks of missiles by use of special test equipment to check missile reliability.

COOKIE CUTTER: Slang term for booster contactor.

DECANNING: Removal of missile components and boosters from their shipping containers.

DORSAL FINS: Stabilizing fins, permanently fixed to certain types of missiles.

E-SECTION: Section of the missile containing the electronic components.

FEEDER SYSTEM: Major component of the guided missile launching system, serves as magazine and feeds launcher rails in automatic or step control.

FORWARD BOOSTER SHOES: Two U-shaped lugs used for handling and firing the weapon.

GMLS: Guided missile launching system.

GRASSHOPPER: Four wheeled dolly equipped with aircraft shock absorbers, especially designed to handle missiles and boosters for highline rearming at sea operations.

GUIDANCE PHASE: Phase of missile flight during which missile is under control of the radar guidance beam.

HANDLING SYSTEM: Feeder system.

HT: Homing, tail controlled missile.

MACH NUMBER: Ratio of flight speed to speed of sound.

OFFLOADING: Removal of missiles, boosters, and other missile components from ship's magazine.

QUADPAK: Four missile sections, assembled and packed in one container.

SEEKER: Section of the missile containing the homing device.

SEPARATION TIME: Time at which booster separates from missile (end of boost phase).

STEP CONTROL: Type of local control used for step by step operation of the guided missile feeder system and launcher guide arm components.

STRIKEDOWN: Loading of ship's magazines with missiles, boosters, and other missile components.

SUPERSONIC: Faster than speed of sound.

SUSTAINER: Section of missile, loaded with solid fuel propellant or filled with liquid fuel, to sustain missile flight after booster separation.

TELEMETERING: Transmission of flight information from missile to launching station, via radio energy.

T-LUGS: Slang term for aft booster shoes.

TRIPAK: Three missile sections, assembled and packed in one container.

U-LUGS: Slang term for forward booster shoes.

WARMUP: Application of power to electronic components within missile.

WEAPON: Common reference to missile/booster combination, winged and finned, ready for firing.

Each major component of a guided missile has mark and mod numbers. Starting with the development of the BT3 missile, all complete missile/booster combinations have also been assigned mark and mod numbers.

INTRODUCTION TO A TYPICAL MISSILE WEAPON SYSTEM

General descriptions of some Terrier guided missile types used by DLG class ships follow.

BW1 - The BW1 missile has a beam riding guidance system and uses fragmentation (F) or continuous rod (CR) warheads which are detonated by a proximity fuze. The BW1 is roll stabilized by the differential motion of two rollerons on the tailfin assembly. Direction of the BW1 is controlled by wing movement.

BT3 - The BT3 missile has a beam riding guidance system and can be assembled with fragmentation or continuous rod warheads which are detonated by a proximity fuze. The BT3 can also be equipped with a special (N) warhead. The missile is controlled throughout its flight, the four independently movable tail surfaces control flight direction and stabilize roll.

HT3 - The HT3 missile is similar in configuration to the BT3; however, it has a homing guidance system instead of a beam riding guidance system. The missile may be equipped with a fragmentation or continuous rod warhead.

TOPIC 2: INTRODUCTION TO GMLS MK 10 MOD 0

You Are Now Going to Learn:

1. General arrangement of the GMLS Mk 10 Mod 0.
2. Sequence of operations.

Discussion Points for this Topic Are:

1. Location and arrangement of the GMLS Mk 10 Mod 0 aboard ship.
2. General arrangement of the launcher feeder system:
   a. Strikedown and checkout area.
   b. Assembly area.
   c. Magazine area.
3. Operation of the launcher feeder system.
4. Arrangement of the launching system control components.
5. Functions and arrangements of the dud jettison units.
6. Functions and arrangement of the anti-icing units.
7. Review and summary.

INFORMATION AND DISCUSSION:

The Guided Missile Launching System Mk 10 Mod 0, shown in the illustration on the facing page, is part of the Terrier weapon system aboard DLG class destroyers. The Mk 10 Mod 0 system consists of the following major components:

1. Launcher Mk 5 Mod 3.
2. Launcher feeder Mk 10 Mod 0.
3. Missile launching system control Mk 8 Mod 0.
4. Dud jettison units Mk 108 Mod 0.
5. Anti-icing system.
6. Strikedown and checkout equipment.

The launching system is located near the aft end of the ship and is divided in two sides by the ship's centerline. Each of these sides (A and B) is capable of delivering a missile from the magazine to the launcher.

The dual arm (A and B) horizontal loading launcher is mounted in an exposed position on the main deck, just aft of the break in the aft deckhouse (missile house).

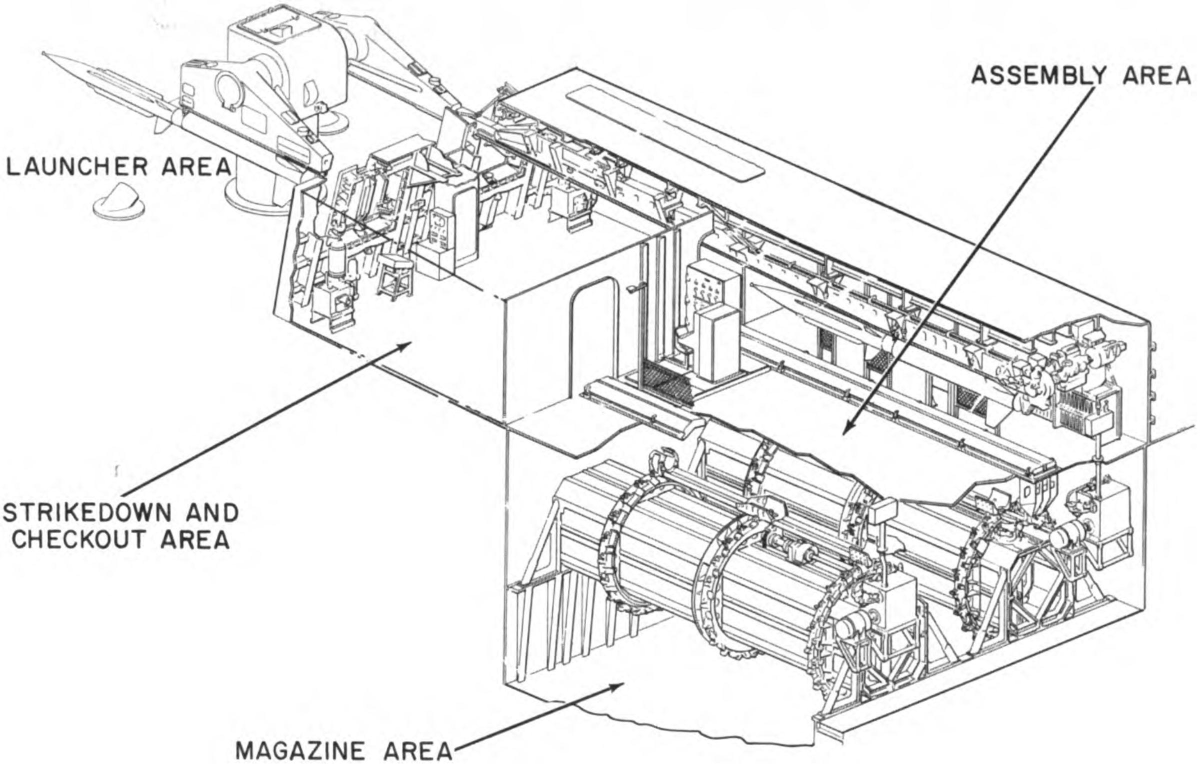
One part of the launcher feeder is located on the main deck and is enclosed by the missile house; the rest of the feeder components are located on the first and the second decks, below the main deck.

The aft deckhouse is divided into two compartments: The compartment nearest to the launcher is called the strikedown and checkout area, and the compartment furthest from the launcher is called the assembly area.

Located directly below the assembly area is the magazine area. The missiles in the magazine are stowed on two horizontally mounted ready service rings. A magazine door, located over each ready service ring, separates the magazine area from the assembly area. Two loader rails, located over the magazine doors, extend through the assembly area and strikedown (checkout) area to a pair of blast doors. When closed, the blast doors prevent the missile blast from entering the missile house. When the blast doors are open, they provide a rail extension by which the launcher guide arms are connected to the loader rail.

The following is a brief listing of feeder operations required to load a missile onto the launcher.

1. The ready service ring rotates a missile under the magazine door.
2. The magazine door opens.
3. The missile is hoisted to the loader rail.
4. The wings and fins are mounted on the missile.



119. GMLS MK 10 MOD 0, GENERAL ARRANGEMENT

5. The blast doors open.
6. The loader extends, positioning the missile on the launcher guide arm.

The launching system control Mk 8 Mod 0 consists of the panels and electrical cabling necessary for launching system operation and maintenance. All normal operating panels are located in the assembly area; the test panel and dud jettison panel, however, are located at the launcher end of the checkout area.

The two dud jettison units (one for the launcher A-arm and one for the launcher B-arm) are located on the main deck, just aft and on each side of the launcher. The units provide a means of getting rid of misfired missiles by jettisoning them overboard.

An anti-icing system is provided to heat the external areas of the system where ice accumulation could interfere with system operation.

The anti-icing fluid tank is mounted below the launcher. The heated fluid is circulated by a motor driven pump through imbedded passages in the following launching system areas:

1. Top of launcher stand.
2. Trunnion bearing areas of the trunnion support.
3. Launcher guide rails.
4. Blast doors and blast door frames.
5. Perimeter of the dud jettison housings.

The equipment for handling major missile components during strikedown and checkout is provided in the strikedown and checkout area of the missile house. This equipment is also used during the intertransfer of missile booster combinations from one loader rail to the other. (More information on strikedown equipment will be provided in Topic 9 of this section.)

Certain modifications of the missile launching system Mk 10 are used on ships other than DLG class destroyers. The location of these systems aboard ship may differ from the one described in this topic; however, the general arrangement of all Mk 10 launching systems is similar.

TOPIC 3: MISSILE MAGAZINE COMPONENTS

You Are Now Going to Learn:

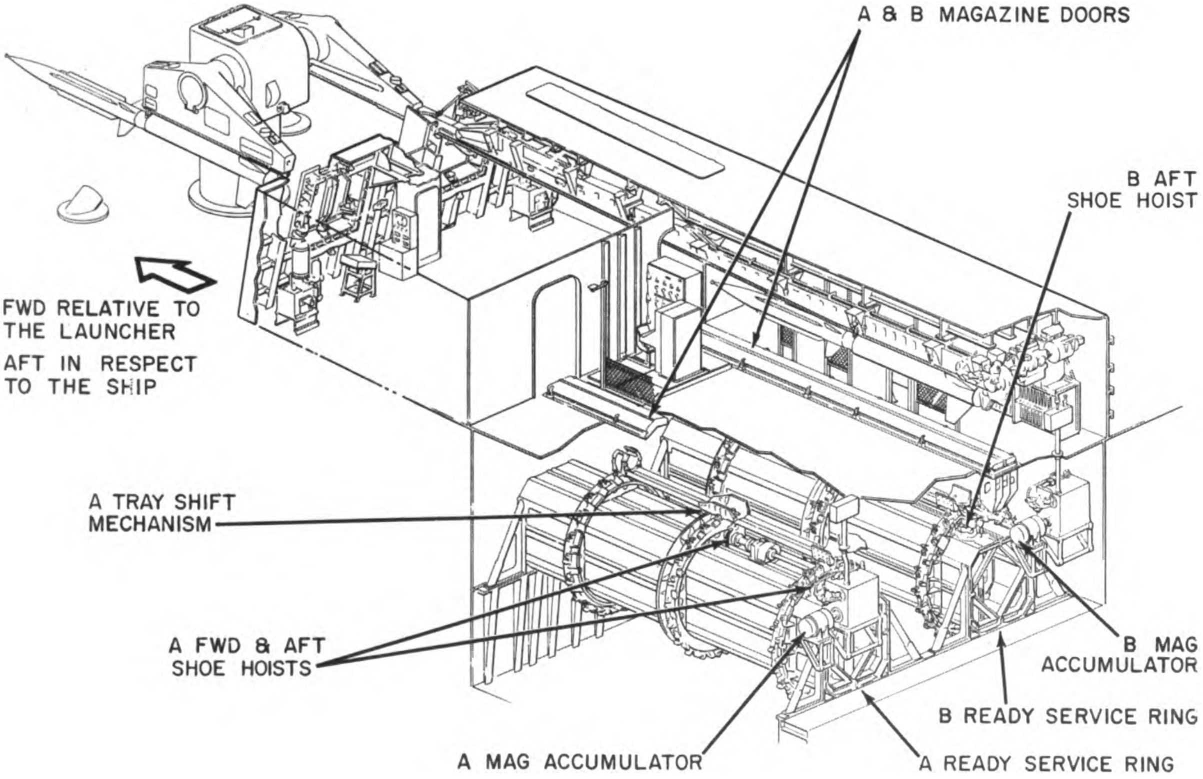
1. Location, purpose, and construction features of the magazine and magazine components.

Discussion Points for this Topic Are:

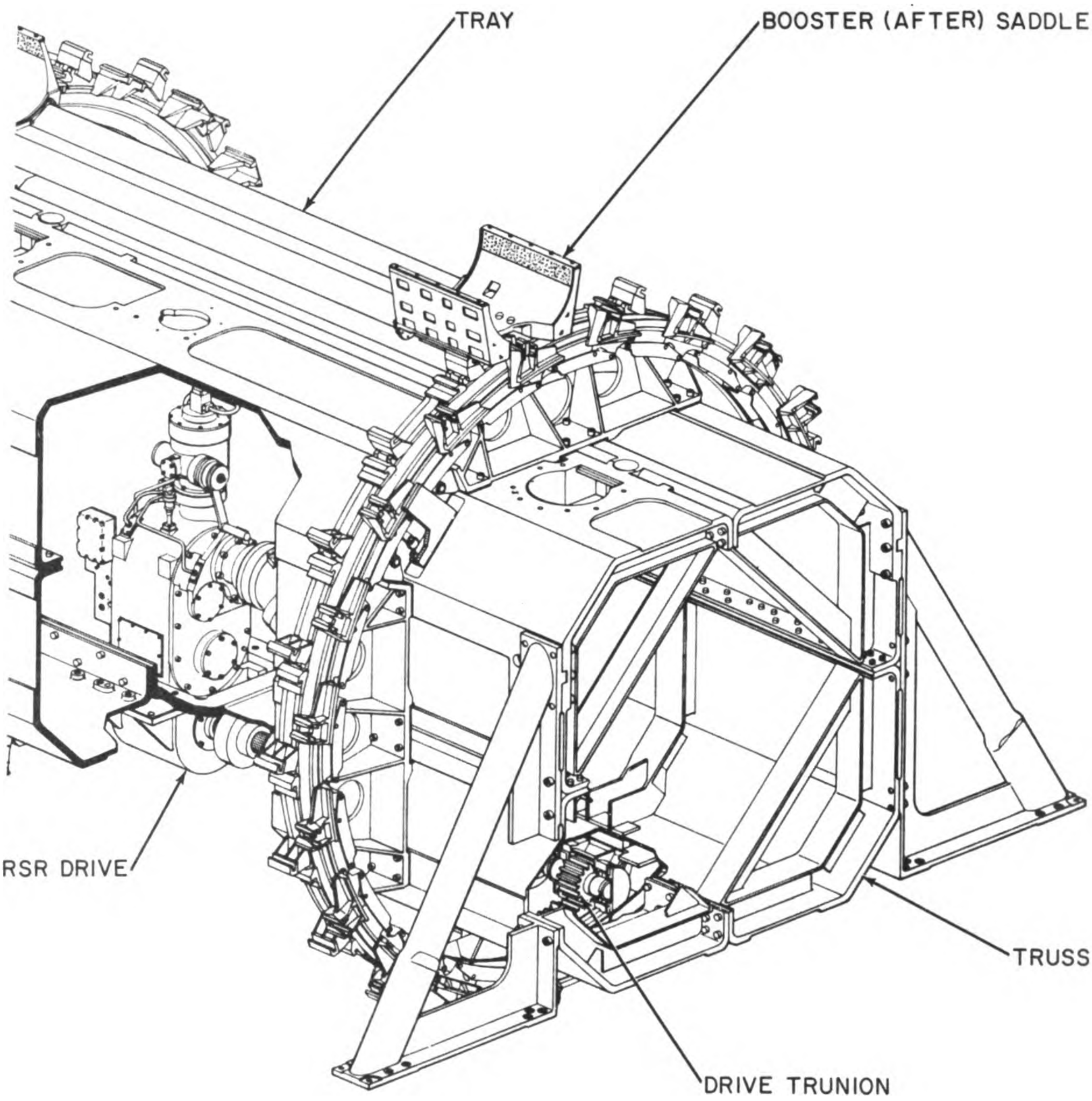
1. Magazine, general arrangement.
2. Location, purpose, and construction features of the ready service ring (RSR).
3. Location, purpose, and construction features of the tray and tray shift mechanism.
4. Purpose and construction features of the magazine doors.
5. Purpose, location, and construction features of the hoist.
6. Purpose, location, and construction features of the magazine accumulator power supply.
7. Review and summary.

INFORMATION AND DISCUSSION:

The missile magazine is located in the area below the main deck. The magazine area contains the A-side and B-side ready service rings (RSR), hoists, and magazine accumulator power drives. Two sets of magazine doors, mounted on the main deck above the magazine hoists and ready service rings, form a flameproof closure over the main deck openings through which the missile booster combinations pass during the loading or unloading cycle. (Major components of the magazine are shown in the illustration below.)



120. MAGAZINE COMPONENTS

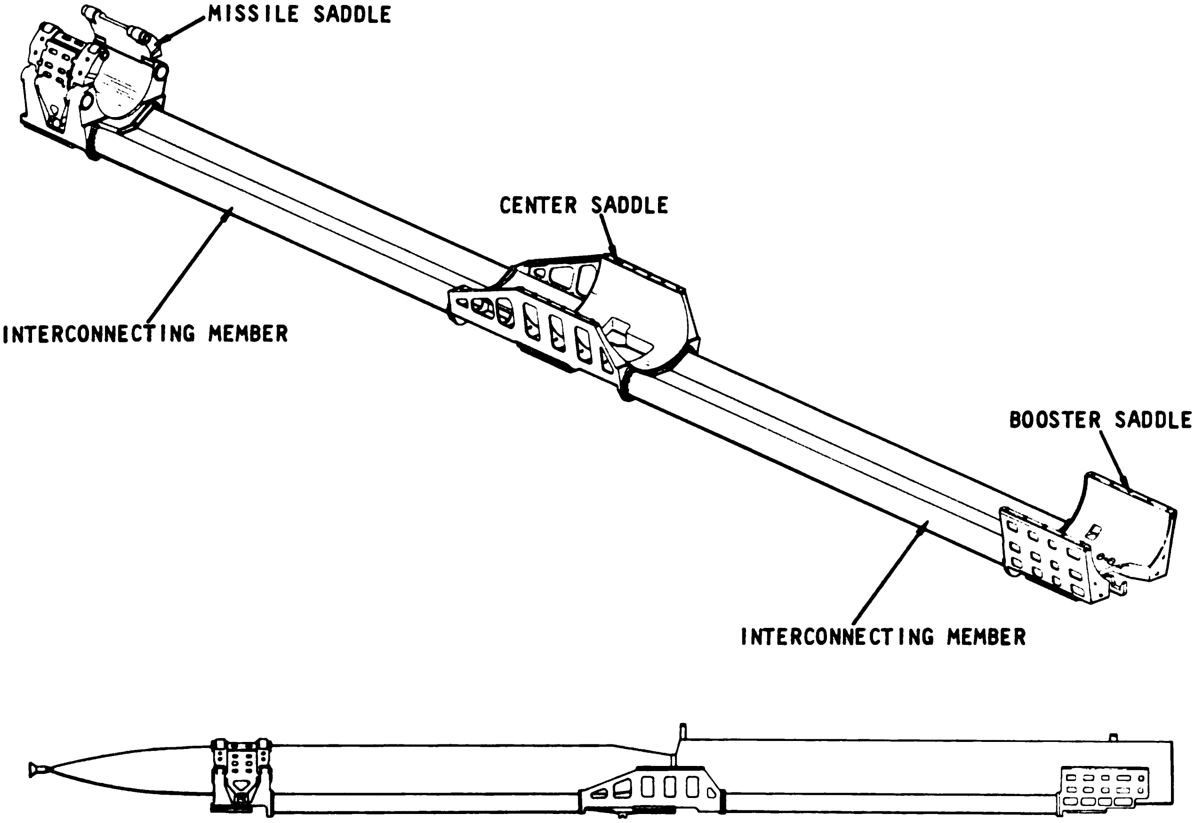


121. BOOSTER (AFT) BEARING ASSEMBLY

The ready service ring (RSR) consists of three bearing assemblies mounted on a four sided truss. The slide blocks on the bearing assemblies mate with the slides on the missile booster trays, thereby retaining the trays on the ready service ring.

The forward and aft bearing assemblies are driven by a pinion gear, while the center bearing assembly floats on roller bearings. The RSR may be driven in either direction by a hydraulic motor, to bring a specified missile to the transfer point where it can be raised by the hoist onto the launcher loader. (The aft bearing assembly is shown in illustration above).

NOTE: Unless otherwise noted, forward and aft in this section is in relation to the launcher, not to the ship.



RELATION OF MISSILE TO TRAY

122. READY SERVICE RING TRAY

The tray supports the missile booster combination on the RSR. Sliding brackets connect the tray to the RSR and provide bearing surfaces which allow forward and aft movements of the tray.

The tray assembly, shown in the illustration above, consists of three saddles and two interconnecting members. The booster (aft) saddle supports the aft end of the booster and provides a retainer for the aft booster shoe (T-lug).

The midsection of the missile booster combination is supported by the center saddle. Bearing blocks are bolted to the center saddle to provide a mechanical connection to the tray shift mechanism.

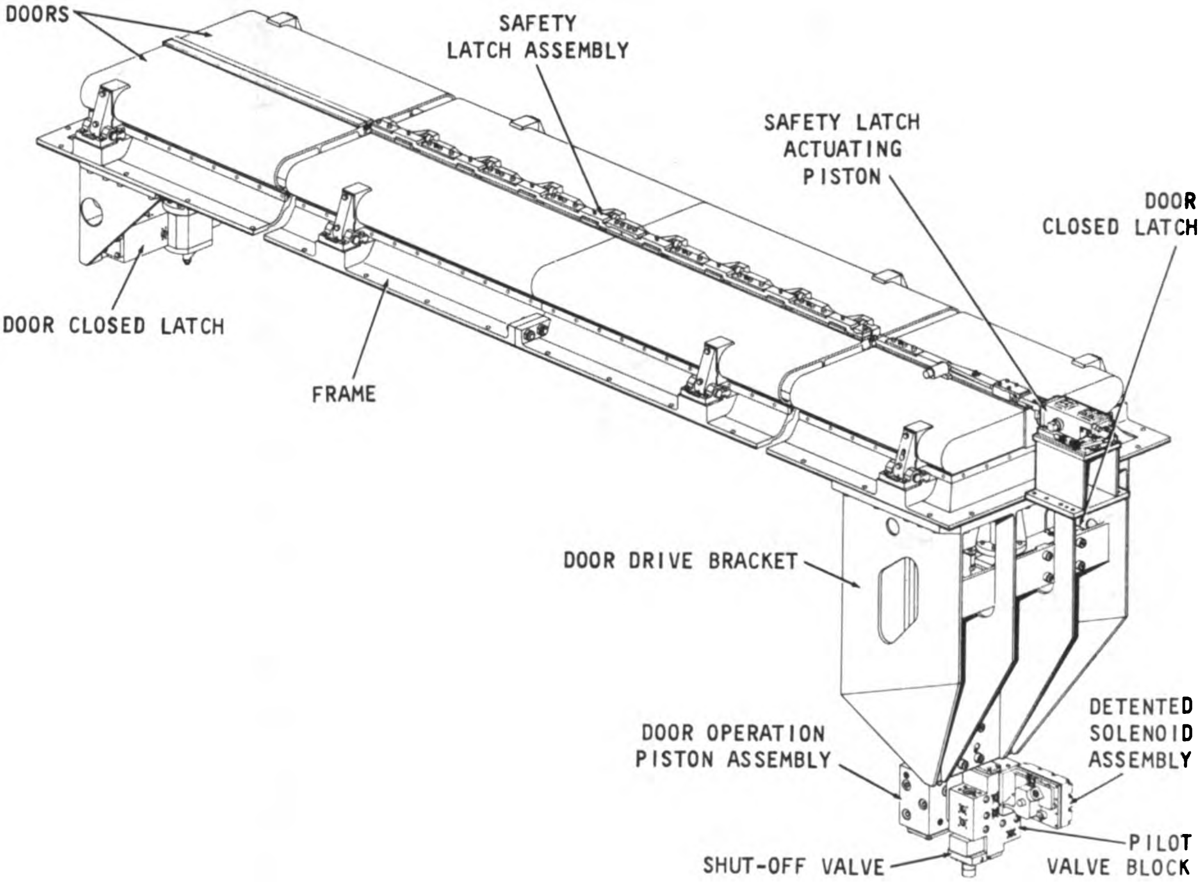
The missile (forward) saddle cart supports the missile by means of clamp arms. When the tray is shifted to transfer a missile to the hoist, the clamp arms pivot outward to release the missile.

The tray shift mechanism is used to transfer a missile either from the RSR to the hoist or from the hoist to the RSR. The tray can be moved by extending a hydraulically operated piston rod, to disengage the booster shoes from the tray and to engage them with the hoist.

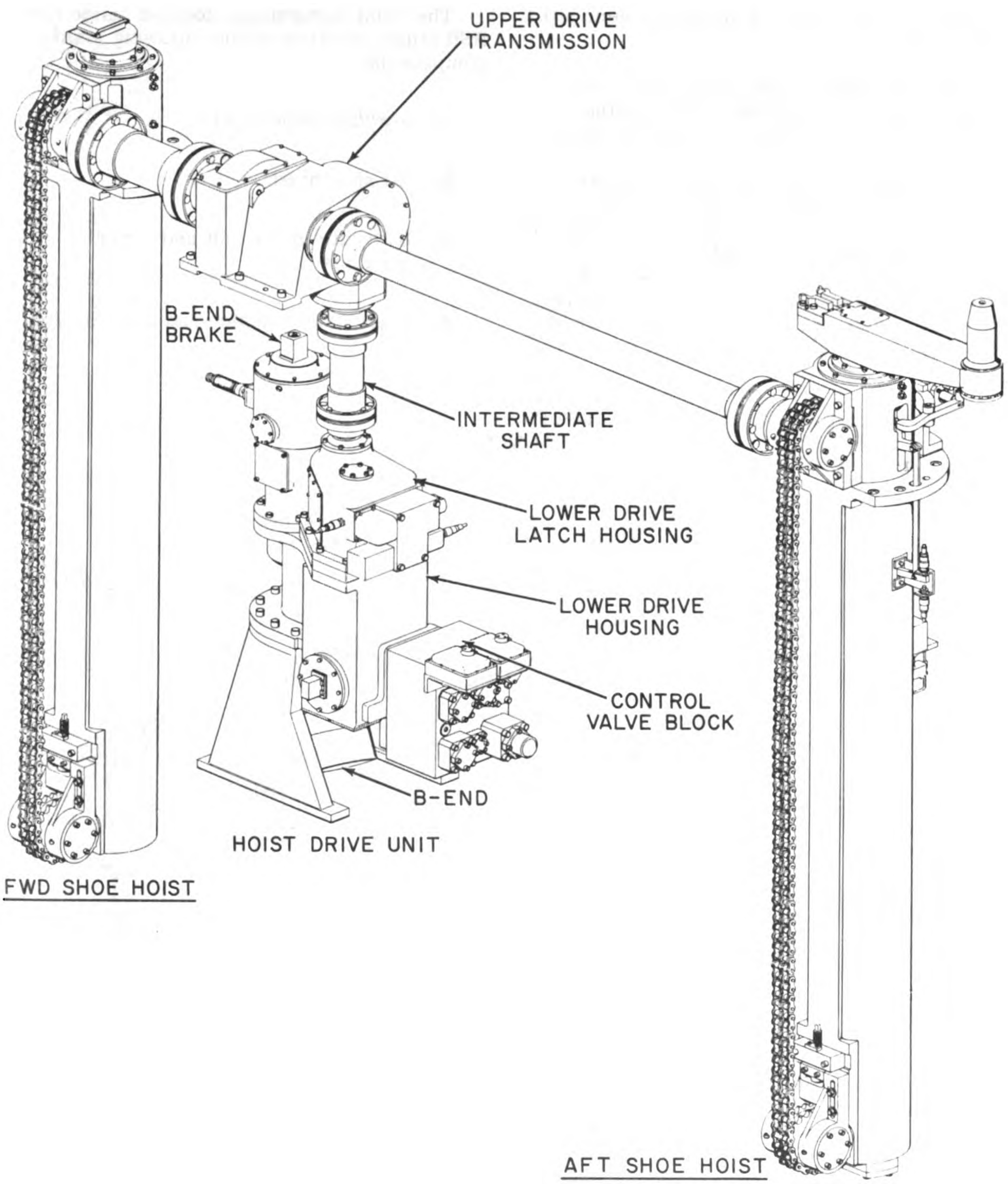
The magazine doors are located in the deck between the assembly area and the missile magazine. When closed, the doors provide a flameproof seal between the two areas; when open, they allow transfer of missile booster combinations to and from the magazine. The doors are hinged at their outer sides and are hydraulically opened upward. The doors, can be locked, open or closed, by either a hydraulically or a spring operated latch. (A magazine door assembly is shown in the illustration below.)

The hoist mechanism, located inside the RSR truss, consists of the following main components:

1. Forward shoe hoist.
2. Aft shoe hoist.
3. Hydraulic drive unit and lower transmission.
4. Upper transmission and drive shafts.



123. MAGAZINE DOOR ASSEMBLY



124. HOIST MECHANISM, GENERAL ARRANGEMENT

The hoist mechanism can transfer a booster or a missile booster combination from the RSR trays to the launcher loader rail and vice versa. (The general arrangement of the hoist mechanism is shown in the illustration on the preceding page.)

A magazine accumulator power supply system is located on the bulkhead near the RSR booster (aft) bearing assembly. The four accumulators for the system are located in the RSR truss. Separate power supplies are used for each side (A and B). The accumulator system supplies hydraulic fluid for operation of the following magazine components:

1. RSR drive motor.
2. Tray shift mechanism.
3. Magazine hoist.
4. Magazine doors.

The accumulator power system consists of the following major components:

1. Electric motor.
2. Piston pump.
3. Supply tank.
4. Header tank.
5. Control valve block.
6. Accumulators.

TOPIC 4: LAUNCHER LOADER AND LOADER COMPONENTS

You Are Now Going to Learn:

1. Location, purpose, and construction features of the launcher loader and loader components.

Discussion Points for this Topic Are:

1. Location, purpose, and construction features of the launcher loader.
2. Location, purpose, and construction features of the loader positioner.
3. Location, purpose, and construction features of the floating tracks.
4. Location, purpose, and construction features of the blast doors and spanning rail.
5. Location, purpose, and general arrangement of the loader accumulator power supply system.
6. Review and summary.

INFORMATION AND DISCUSSION:

The launcher loader Mk 8 transmits the missile booster combination from the assembly area to the launcher guide arm. Two loaders (A- and B-side) are utilized in the GMLS Mk 10. (Since the two loaders differ only in assembly designations, only one loader will be discussed.)

The loader is mounted on the overhead of the missile house and spans from the assembly area to the blast doors. Included as part of the loader is the spanning rail which is connected to the upper blast door.

The missile booster shoes ride in tracks in the spanning rail. Tracks are also provided in the rail for the warmup cable and pawl drive chain.

The loader trunk which supports the loader track is divided in eight sections. (Refer to illustration at the top of the following page.) The eight trunk sections and the units they include are listed below:

Section I: Includes the hydraulic drive motor, warmup cable drum, aft floating track, and loader positioner.

Section II: Contains only the track.

Section III: Includes the forward floating track.

Sections IV and V: Contain only the track.

Section VI: Includes the aft shoe retractable rails and the spanning rail operating cylinder.

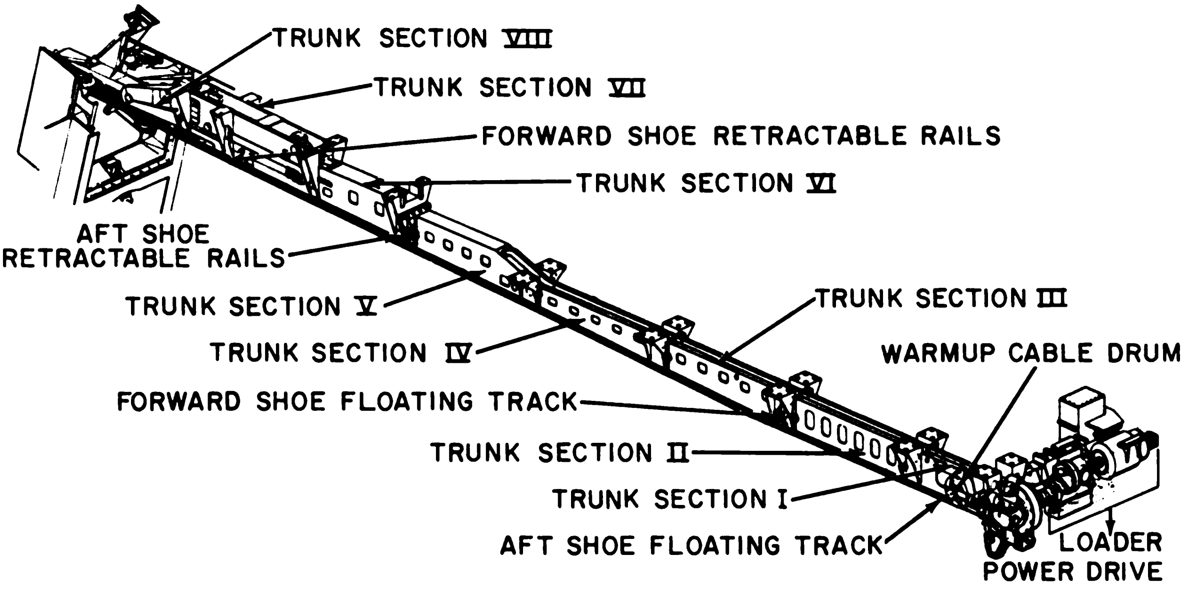
Section VII: Includes the forward shoe retractable rails and spanning rail hydraulic components.

Section VIII: Acts as a forward support for the forward end of the loader trunk.

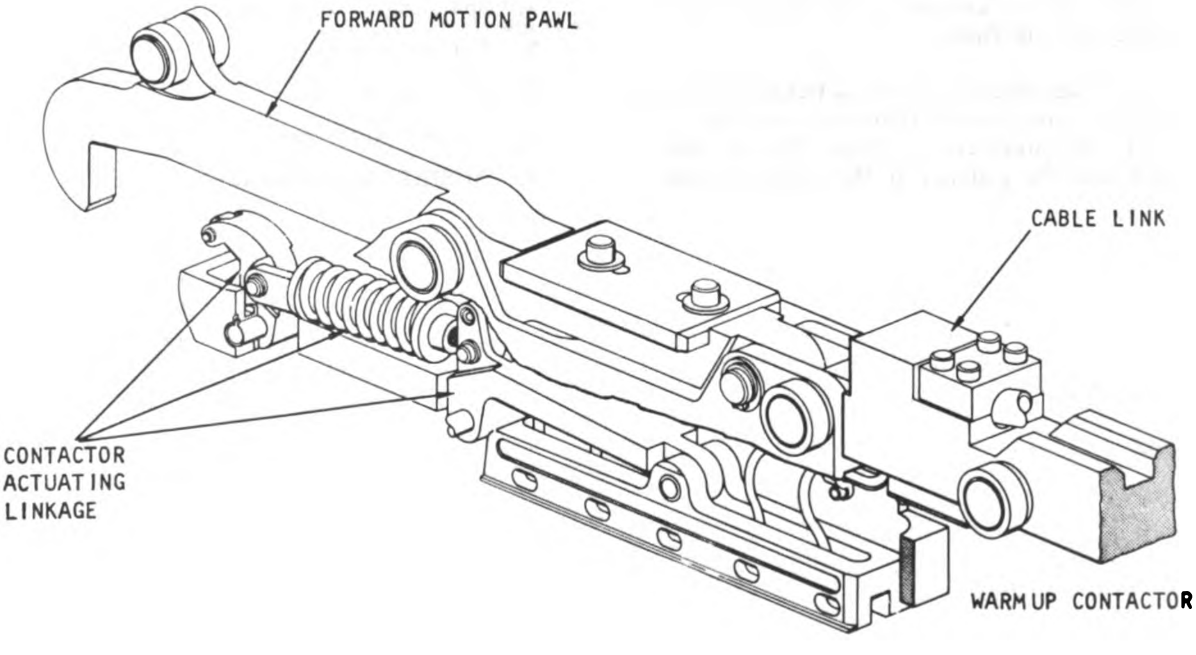
When the missile enters the loader track, the loader pawl is latched to the booster shoe. The pawl is positioned by a rammer-type chain which is driven by a hydraulic motor.

The pawl assembly includes a loader warmup contactor which warms up the missile when it is in the assembly area and while it is being positioned on the launcher. A warmup cable, connected to the loader pawl, is wound on a spring-loaded drum and extends with the loader pawl when a missile is positioned on the launcher. (The pawl assembly is shown in the illustration at the bottom of the facing page.)

The loader positioner, located in Trunk Section I, can transfer a booster or missile booster combination from the hoist to the loader or vice versa. The transfer is accomplished by a hydraulic actuator with linkage which bends the loader chain upward or straightens it out, to move the loader pawl the amount necessary to move the booster shoes in or out of the loader rail.



125. LOADER, GENERAL ARRANGEMENT



126. LOADER PAWL ASSEMBLY

The forward and aft floating tracks are located at the points where the booster shoes enter and leave the loader rail. When released, the floating tracks allow for small misalinements or overtravel of the hoist when it raises a missile to the rail.

The floating tracks also allow for misalinements between the missile and hoist when the RSR is being loaded.

Before the missile is moved to or from the floating tracks, the tracks must be lowered to properly aline them with the loader rail. The floating tracks are lowered and released by a hydraulic piston.

Vertical engagement of a booster with the loader rail is also possible in the strikedown and checkout area. Hydraulically actuated retractable rails permit the booster to be removed from or positioned on the rail by a checkout car.

The blast door assembly is located on the bulkhead between the strikedown area and the launcher. The doors consist of two rectangular steel weldments, hinged at the sides and opened or closed by the spanning rail when it extends or retracts. The doors are connected to the spanning rail by ball jointed connecting link rods.

The blast doors provide a passage for the missiles being moved from the assembly area to the guide arms. When closed, the doors seal the passage in the bulkhead and prevent the blast gases and water from entering the missile house. The doors are locked closed by two sets of hydraulically actuated latches.

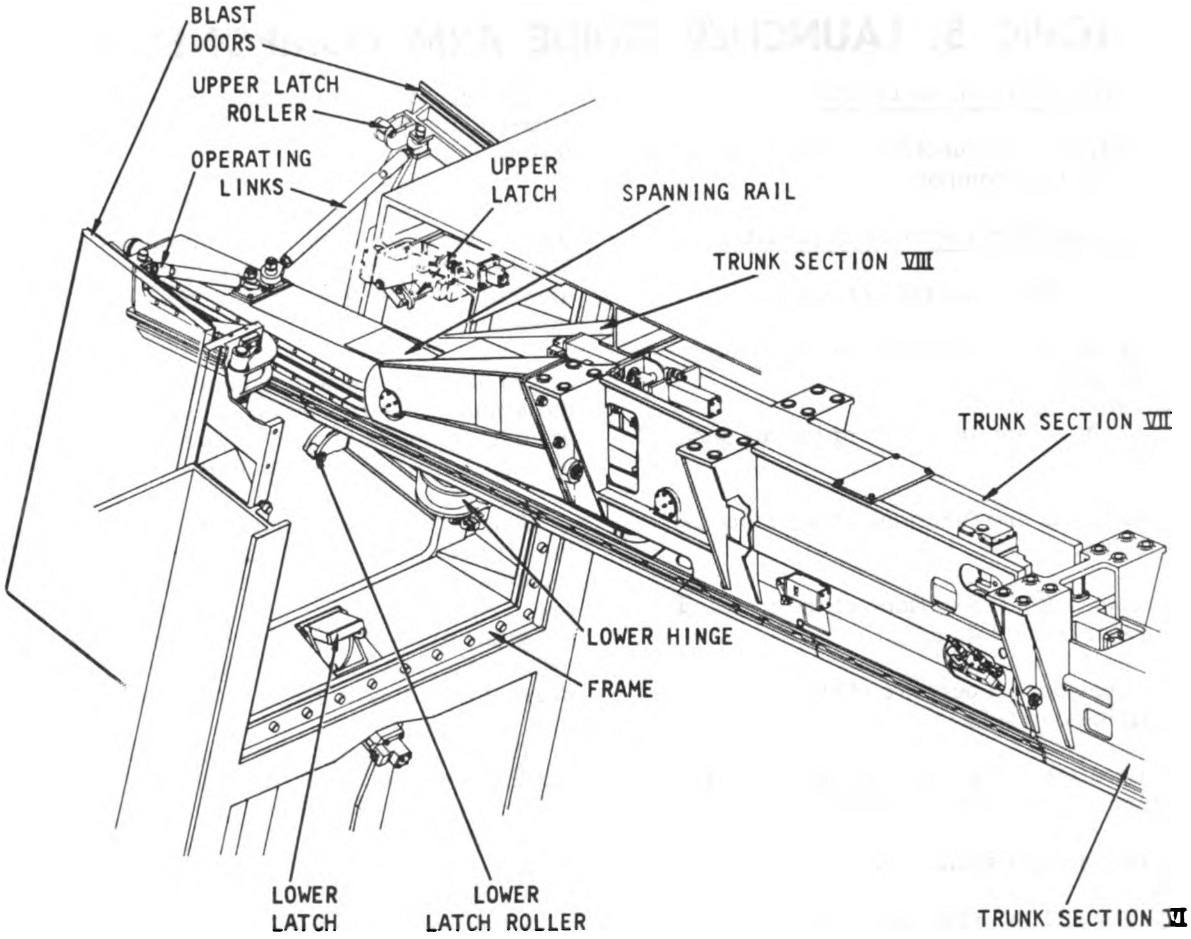
Anti-icing fluid is channeled to each door through the door hinges, to prevent the doors from becoming inoperative due to cold weather.

The spanning rail is a hydraulically operated section of the loader rail. When extended, the spanning rail spans the gap between the loader trunk and launcher guide arms; when retracted, the spanning rail is housed in the loader trunk. (The general arrangement of the blast doors and spanning rail is shown in illustration on facing page.)

The loader accumulator power supply systems (A and B) are located in the strikedown area, on the outboard side of the loader trunks. These systems are similar to the accumulator systems used in the missile magazine.

The loader accumulator power supply system furnishes hydraulic fluid under pressure to operate the following major units:

1. Spanning rail and blast doors.
2. Retractable rails.
3. Floating rails.
4. Loader positioner.
5. BUSHIPS strikedown equipment.



127. SPANNING RAIL EXTENDED, BLAST DOOR OPEN

TOPIC 5: LAUNCHER GUIDE ARM COMPONENTS

You Are Now Going to Learn:

1. Location and functions of the launcher guide arm components.

Discussion Points for this Topic Are:

1. Guide arm, general arrangement.
2. Location and functions of the arming devices.
3. Location and functions of the aft shoe latch.
4. Location and functions of the launcher contactor.
5. Location and functions of the forward restraining latch.
6. Location and purpose of the booster firing contacts.
7. Location and purpose of the guide arm accumulator power drive.
8. Review and summary.

INFORMATION AND DISCUSSION:

The launcher guide arms consist of two identical assemblies (A and B), located on each side of the launcher trunnion support. The guide arms are triangular. Each arm is bolted to one end of a common trunnion tube; therefore, both arms must elevate and depress together. The guide arms support the missile during the last stage of weapon handling.

The guide arms contain the following components:

1. Arming devices.
2. Aft shoe latch.
3. Launcher contactor.
4. Forward restraining latch.
5. Firing contacts.

The general arrangement of the guide arm components is shown in illustration on the following page.

The arming device, located in the forward part of the guide arm, arms the missile booster. The arming device houses two arming tools for arming different types of missiles.

To arm the booster, one of the arming tools must be extended and wound. The arming device is caused to function by hydraulically operated pistons.

The aft shoe latch mechanism, located in the aft section of the guide arm, consists of a piston operated latch and associated linkage. When the loader positions a missile on the guide arm, the latch is hydraulically extended against the aft booster shoe, to prevent the missile from moving to the rear.

The aft shoe latch is a mechanism which has many names. For instance:

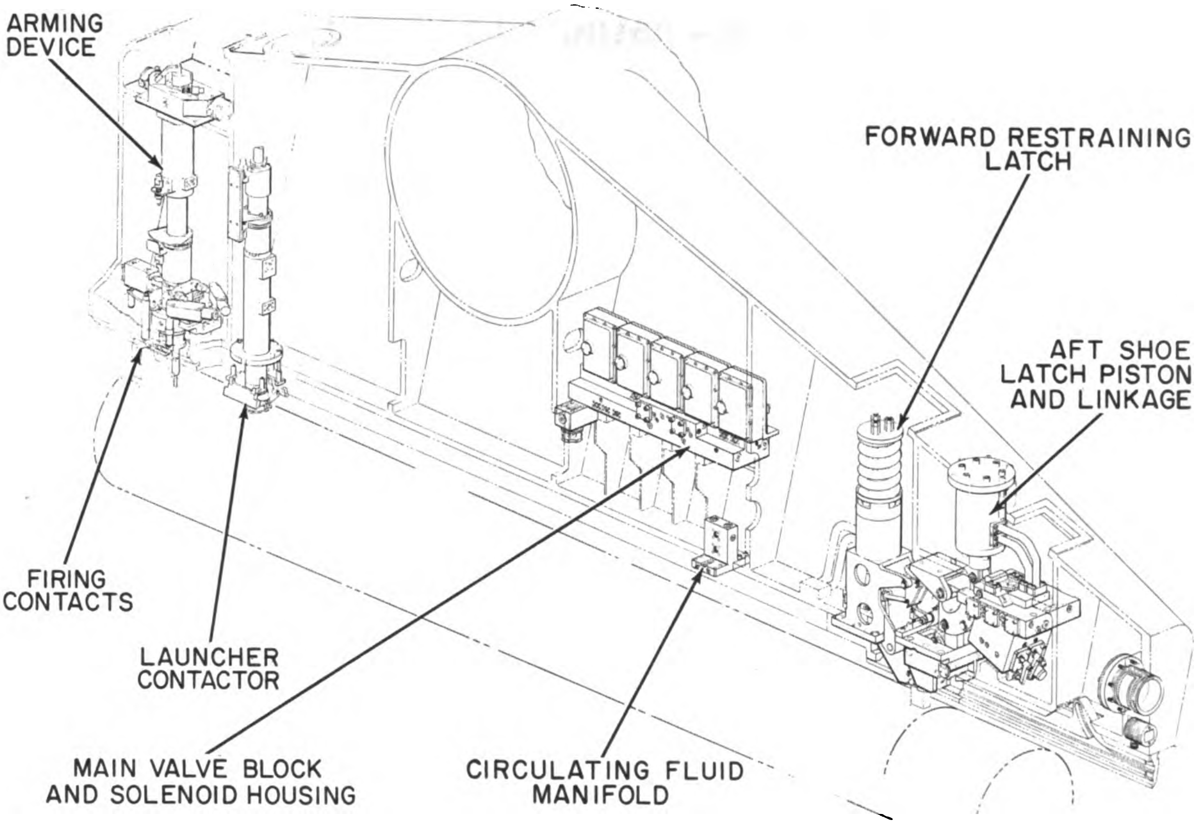
1. Positioner
2. Positioner spade
3. Aft lug latch
4. Aft motion latch
5. Reverse motion latch

} Aft shoe latch

The launcher contactor is located in the forward portion of the guide arm, just aft of the arming device. The contactor is hydraulically extended to apply warmup power to the missile before it is fired.

The forward restraining latch is located in the aft end of the guide arm, just forward of the aft shoe latch. This latch prevents missile forward movement which can be caused by launcher depression or ship motion.

The forward restraining latch also prevents the fired missile from leaving the launcher until the booster has developed enough thrust to completely overcome the force of gravity. This action is accomplished by requiring the booster thrust to overcome the force of an adjustable spring before the forward restraining latch is released.


ARMING DEVICE
FORWARD RESTRAINING LATCH
AFT SHOE LATCH PISTON AND LINKAGE
FIRING CONTACTS
LAUNCHER CONTACTOR
MAIN VALVE BLOCK AND SOLENOID HOUSING
CIRCULATING FLUID MANIFOLD

128. GUIDE ARM COMPONENTS, GENERAL ARRANGEMENT

Two booster firing contacts and two ground contacts are located in the forward section of the guide arm. One firing contact and one ground contact on each side of the arming device, to provide a double firing circuit for the booster.

A guide arm accumulator power drive, located in the trunnion support, supplies both the A- and B-guide arm components with hydraulic fluid for their operation.

TOPIC 6: LAUNCHER MK 5

You Are Now Going to Learn:

1. Location and functions of the launcher components.

Discussion Points for this Topic Are:

1. Primary functions and general arrangement of the launcher.

2. Functions and construction features of the following launcher components:

    a. Stand.
    b. Carriage.
    c. Power drive assembly.
    d. Guide.
    e. Slip ring assembly.
    f. Elevation arc.
    g. Elevation pinion gear.
    h. Elevation reduction gear assembly.
    i. Elevation brake.
    j. Elevation latch.
    k. Elevation positioning valve.
    l. Latch control valve block.
    m. Elevation and depression buffers.
    n. Buffer accumulator.
    o. Hand pump.
    p. Firing cutout mechanism.
    q. Ventilation power unit.
    r. Training circle.
    s. Train brake.
    t. Train positioning valve.
    u. Train latch.
    v. Train reduction gear assembly.

3. Launcher power drive operation.

4. Methods of launcher control.

5. Review and summary.

INFORMATION AND DISCUSSION:

The Missile Launcher Mk 5, as illustrated on the following page, has two primary functions:

1. To receive the weapon and to position it for firing.

2. To prepare the missile for flight and to arm and ignite the booster.

Stand Mk 3 Mod 1:

The stand consists of a fixed, circular steel weldment which is flange mounted to the deck. The stand serves as mounting device for the carriage.

Carriage Mk 3 Mod 2:

The carriage consists of a movable, circular steel weldment which includes a bolted together base ring and trunnion support.

Most launcher components are mounted within or onto the carriage. The carriage is mounted within the stand and may be rotated in a horizontal direction.

The carriage supports the trunnion tube and provides a means of positioning a weapon at the required degree of train.

Power Drive Assembly Mk 46 Mod 1:

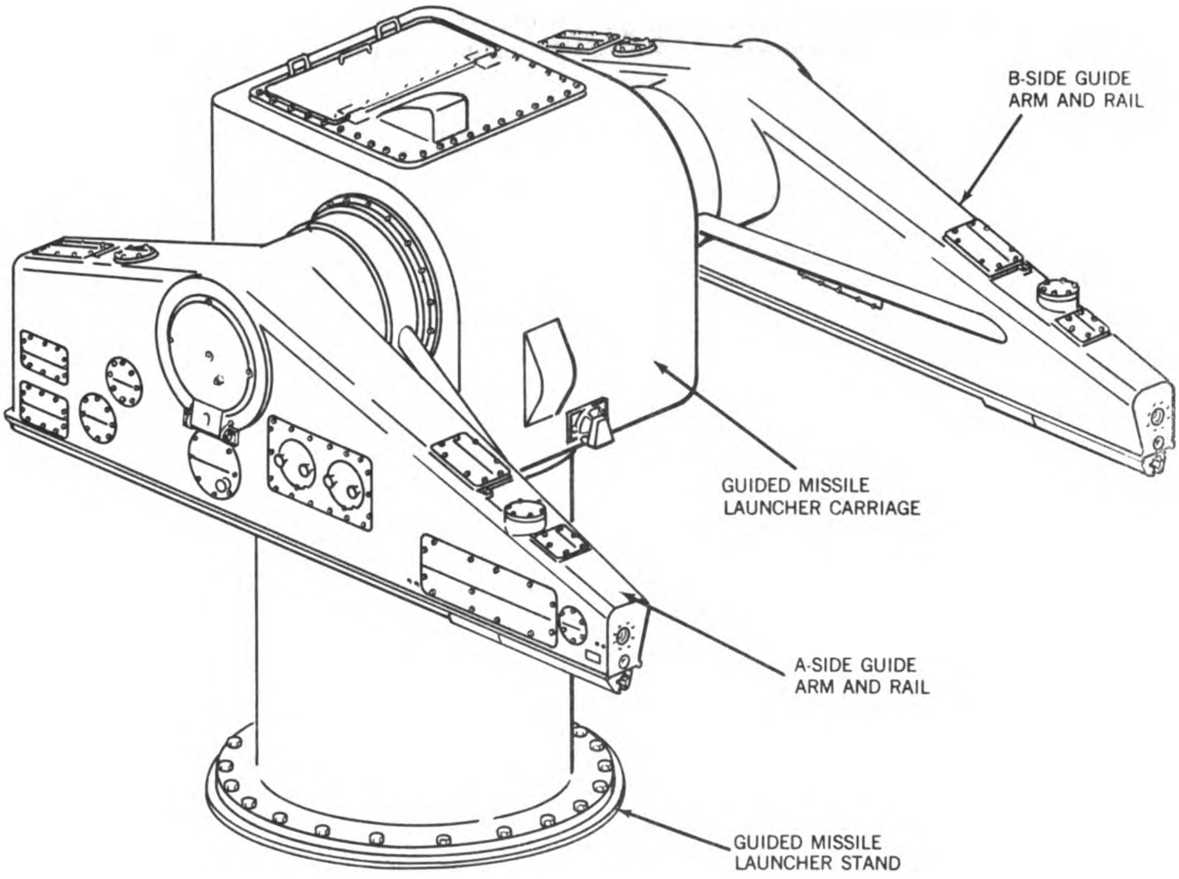
The power drive assembly consists of two separate electric-hydraulic systems which control the movements of the launcher in train and elevation.

Guide Mk 3 Mod 3:

The guide consists of a steel weldment which includes a trunnion tube, an elevation arc, a buffer actuating arm, and the A- and B-guide arms. The guide arms support the weapons on the launcher and provide a means of elevating and depressing the weapon at the required degree of elevation. The unit house houses the mechanisms which control missile and booster firing.

Slip Ring Assembly Mk 4 Mod 2:

The slip ring assembly consists of stationary collector rings and rotating brush fingers housed in an assembly located in the lower carriage section of the launcher. The slip rings supply continuous current to the launcher components, thus eliminating cables that can be twisted and also providing unlimited train.



129. TERRIER LAUNCHER MK 5

Elevation Arc:

The elevation arc is mounted to the trunnion tube and includes a steel gear which transmits the pinion gear motion to the trunnion tube, causing the launcher to elevate or to depress.

Elevation Pinion Gear:

The elevation pinion gear (spur) is meshed with the elevation arc gear and is driven by the reduction gear assembly.

Elevation Reduction Gear Assembly:

The elevation reduction gear assembly consists of a series of steel gears located within a housing which is mounted to the upper center of the carriage, below the trunnion tube.

Elevation Brake:

The elevation brake is a hydraulically operated, spring loaded friction clutch, located on the reduction gear housing. The brake is constructed of steel and sintered bronze plates. During power off conditions, the brake sets and prevents the launcher from moving.

Elevation Latch:

The elevation latch is a hydraulically operated steel pin, located below the reduction gear housing. When the latch is extended, it secures the launcher in the Load (0°) position.

Elevation Positioning Valve:

The elevation positioning valve is a spring loaded, hydraulically operated valve, located below the elevation arc. The valve actuates an interlock switch when the launcher is in elevation Load position.

Elevation Latch Control Valve Block:

The elevation latch control valve block consists of a metal housing, located below the reduction gear housing. It houses the solenoids and valves which control the elevation latch.

Elevation and Depression Buffers:

The elevation and depression buffers are hydraulically operated steel pistons, mounted to each side of the trunnion tube. The buffers buff the movements of the trunnion tube, thus preventing excessive stress on the missile when the guide arms reach the elevation or depression limits.

Buffer Accumulator:

The buffer accumulator is mounted on the upper left side of the carriage. The accumulator furnishes a supply of hydraulic fluid for buffer operation.

Hand Pump:

The hand pump is mounted to the left side of the carriage. During power failure and maintenance operations, the pump provides a means of operating the guide arms and the components of the train and elevation latch.

Firing Cutout Mechanism:

The firing cutout mechanism is located forward, at the center of the trunnion support. The mechanism houses the components which prevent the launcher from firing into own ship structure.

Ventilation Power Unit:

The ventilation power unit is located below the launcher stand and provides air, through ducts, to cool the interior of the launcher.

Training Circle:

The training circle consists of a circular steel gear mounted to the stand. The circle provides a geared track on which the train pinion gear can move around, to position the launcher in train.

Train Brake:

The train brake is mounted to the bottom of the carriage. It is constructed and functions in the same way as the elevation brake.

Train Positioning Valve:

The train positioning valve is mounted to the bottom of the carriage. The train positioning valve performs the same functions as the elevation positioning valve.

Train Latch:

The train latch is mounted to the bottom of the carriage. It is constructed and functions in the same way as the elevation latch.

Train Reduction Gear Assembly:

The train reduction gear assembly is located within a housing mounted to the bottom of the carriage. The gears transmit the output of the hydraulic motor, at the required speed, to the pinion gear.

Launcher Operation:

The following is a brief description of launcher operation in train and elevation:

The train order signal, received by the train receiver regulator, is compared with the actual launcher position. The resulting error signal is used to produce a hydraulic output from the power drive pump (A-end). Hydraulic fluid from the A-end causes the motor (B-end) to drive through a reduction gear assembly and to rotate the drive pinion. The drive pinion meshes with the training circle and causes the launcher carriage to rotate.

The elevation power drive is similar to the train power drive, except that rotation of the elevation drive pinion causes the elevation arc to rotate the trunnion tube. The movement of the trunnion tube is imparted to the guide arms, causing them to elevate or to depress.

Methods of Launcher Control:

The launcher is controlled by the following five methods:

1. Remote Control:

The primary means of remote launcher control is an electrical signal received from the remote control station. Remote control is normally used for target tracking and is also the only control method used for weapon firing.

2. Local Control:

Local launcher control is provided by means of an electrical signal received from the local control station at the EP3 panel. Local control is used primarily during routine maintenance operations.

3. Dud Jettison Control:

Dud jettison control is provided by means of an electrical signal, received from a preset synchro located in the EP2 panel, which synchronizes the launcher with the dud jettison units. (This method of control is used only for dud jettison operations.)

4. Load Order Control:

Load order control is provided by means of an electrical signal, received from a preset synchro located in the EP2 panel, which automatically returns the launcher to the Load position after the weapons have been fired from both rails.

5. Test Control:

Test control is provided by means of an electrical signal received from the EP3 panel and is only used for performance of launcher tests. The test order signals are originated by a dummy director.

TOPIC 7: DUD JETTISON ASSEMBLY

You Are Now Going to Learn:

1. Location, purpose, and construction features of the dud jettison assembly.

Discussion Points for this Topic Are:

1. Location, purpose, and construction features of the dud jettison assembly.
2. Principal components of the dud jettison assembly:
    a. A-side and B-side ejectors.
    b. Dud jettison control panel.
3. Clinometer.
4. Review and summary.

INFORMATION AND DISCUSSION:

Dud jettison unit, illustrated on the following page, is a manually controlled, pneumatically operated mechanism which ejects potentially hazardous or unwanted missiles overboard, without igniting their boosters. There are two dud jettison assemblies, one for the A-side and one for the B-side. Both units are similar in construction and operation. The only difference is their location: One is mounted on the starboard side aft and adjacent to the launcher, while the other is located directly across from the first unit. (In the following text only the A-side dud jettison assembly will be explained.)

The main components of a dud jettison unit are as follows:

1. Cylinder weldment.
2. Dump valve assembly.
3. Forward valve assembly.
4. Position latch assemblies.

The upper part of the cylinder includes a stow detent. The flange which is bolted to the deck is also an integral part of the cylinder weldment. The sleeve, located inside the cylinder weldment, may be latched in proper position to correspond with the missile type to be ejected.

The ejector piston slides inside the sleeve. This piston consists of a stainless steel rod and a teflon covered aluminum bronze piston head. The rod opening of the cylinder is equipped with a graphite-impregnated nylon bearing and a neoprene wiper ring. A disk-like pan is attached to the protruding end of the piston rod by means of a self alineing ball and socket joint. This arrangement ensures proper alinement of the pan with the missile booster.

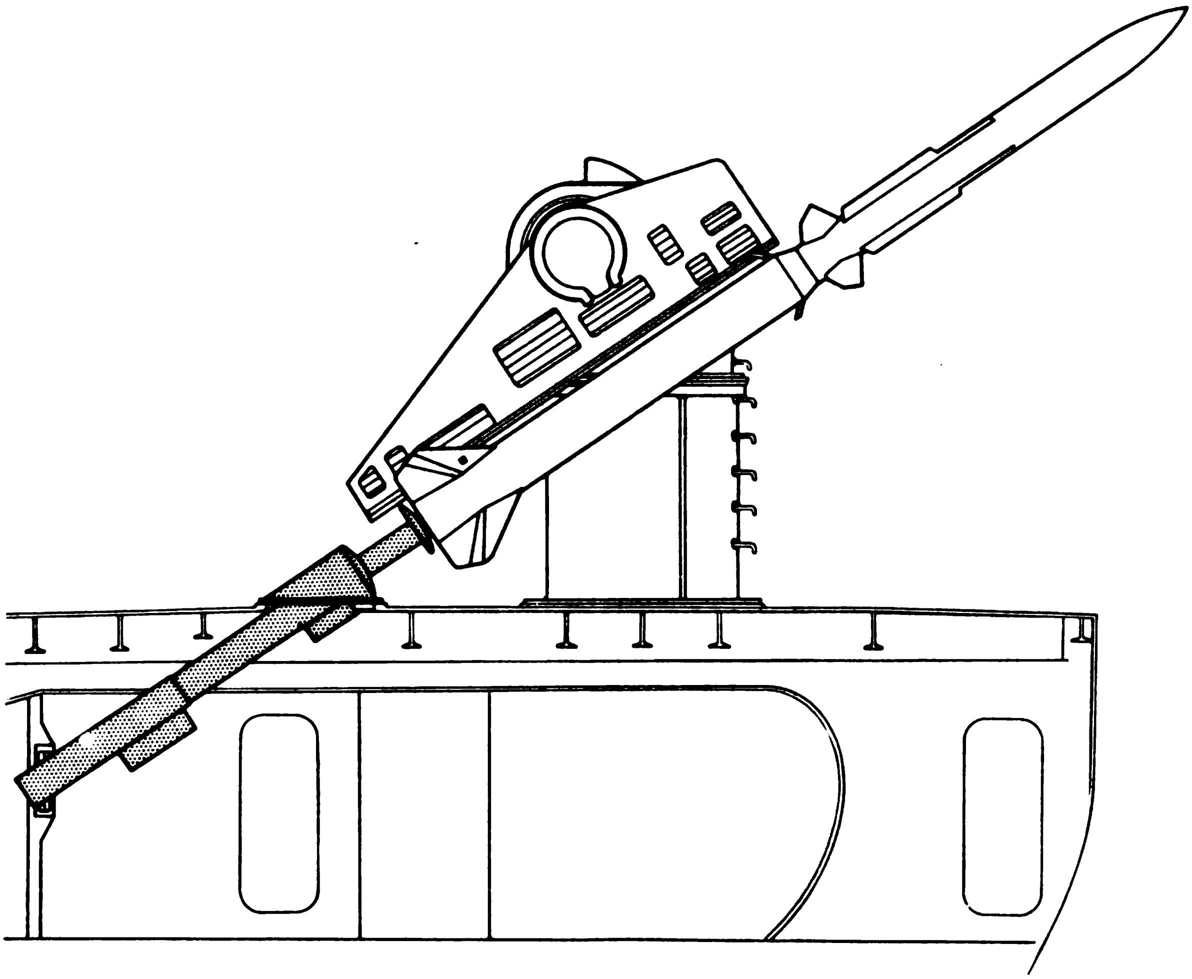
The cylinder weldment also mounts the valve assemblies that control the ejector piston movements. The air charging chamber is an essential part of the piston cylinder.

The dump valve assembly is located near the bottom of the cylinder weldment. Its purpose is to prevent a too sudden return of the sleeve after jettisoning.

The forward valve assembly consists of three valves and is used to control the charging pressure which extends or retracts the ejector piston.

The position No. 1 and No. 2 latches are mounted on the underside and at the approximate center of the cylinder weldment. The latch assembly permits extension of the ejector piston to either one of the two positions, depending upon the type of missile to be ejected.

The stow latch assembly is installed on the upper part of the cylinder weldment. This assembly latches the ejector piston in its retracted position. An arm, fastened to the latch piston, actuates an adjacent switch on the dud jettison control panel. This switch indicates when the ejector piston is in stowed position.



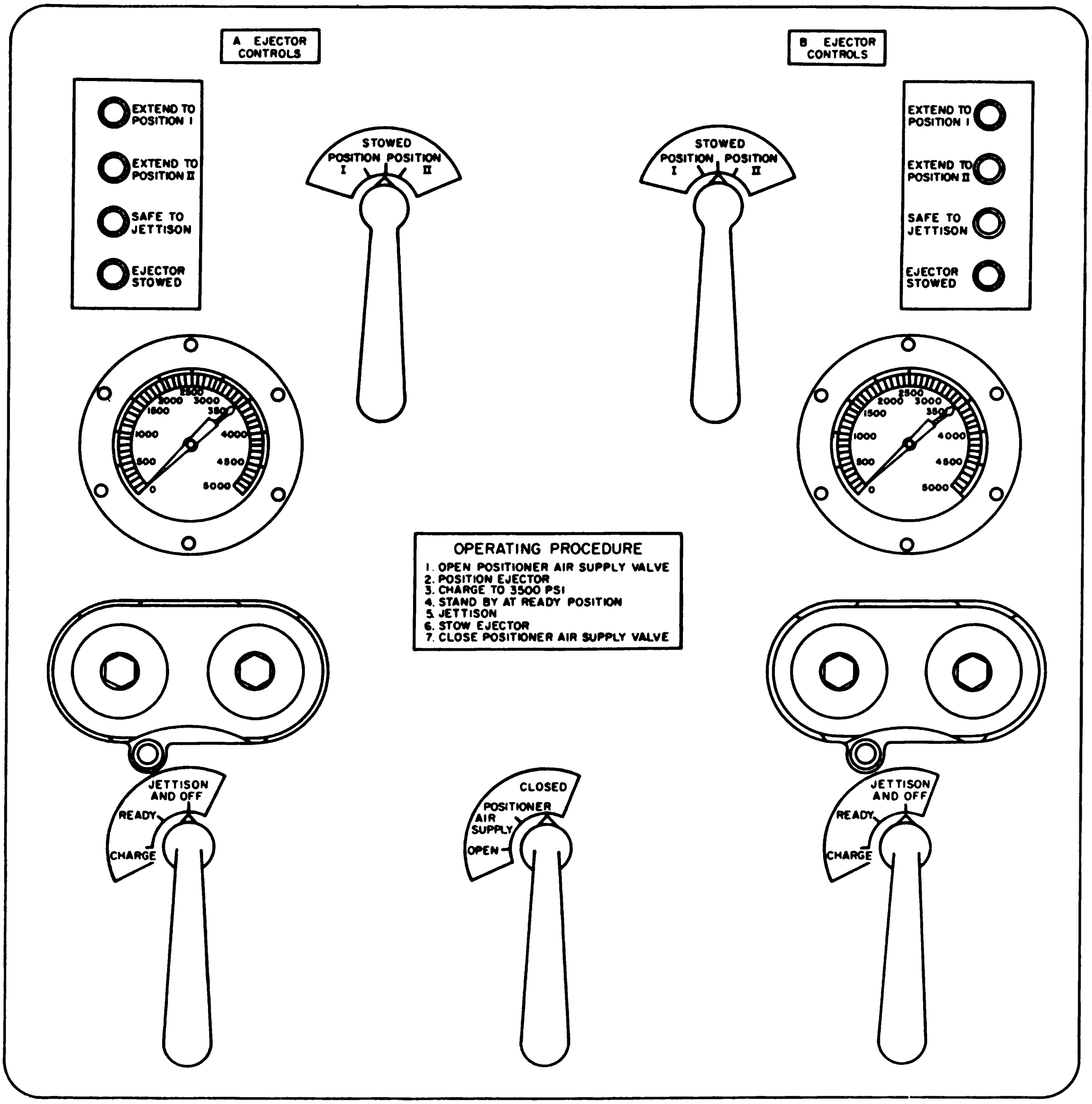
130. DUD JETTISON UNIT

The dud jettison control panel, shown on page 210, is located in the checkout area, adjacent to the A-side blast door and to the launcher test panel EP3. The dud jettison control panel is equipped with separate control valves, indicating lights, and gauges for each ejector. (The A-ejector controls are located on one end of the panel, while the B-ejector controls are located on the other.)

Located on the back of the dud jettison control panel is a high pressure shutoff valve. This standard type, manually operated valve connects the ship's high pressure supply of 3500 psi to the A-side and B-side charging and firing valves on the dud jettison control panel.

The clinometer is a standard, 45 degree, bubble type glass tube which indicates the roll of a ship with reference to its center of gravity. The clinometer is attached to a nearby bulkhead, adjacent to the dud jettison control panel.

Actual jettisoning of any missiles may be performed whenever the roll angle of the ship is under 20 degrees. When the roll angle exceeds 20 degrees, jettisoning should be performed only during downroll.



OPERATING PROCEDURE

1. OPEN POSITIONER AIR SUPPLY VALVE
2. POSITION EJECTOR
3. CHARGE TO 3500 PSI
4. STAND BY AT READY POSITION
5. JETTISON
6. STOW EJECTOR
7. CLOSE POSITIONER AIR SUPPLY VALVE

131. DUD JETTISON PANEL

TOPIC 8: LAUNCHING SYSTEM CONTROL MK 8 MOD 0

You Are Now Going to Learn:

1. Location and purpose of the control panels of the launching system.

Discussion Points for this Topic Are:

1. EP1 panel.
2. EP2 panel.
3. EP4 and EP5 panels.
4. EP3 panel.
5. Review and summary.

INFORMATION AND DISCUSSION:

The launching system control Mk 8 Mod 0 consists of five panels mounted within the deckhouse of each installation. These panels contain electrical circuitry, indicating lights, and various other electrical devices for the operation of the launching system.

The EP1 panel, located in the aft of the assembly area, is the main power supply panel of the launching system. The system is activated when all switches on the EP1 panel are positioned to ON. (The EP1 panel is shown in illustration on the facing page.)

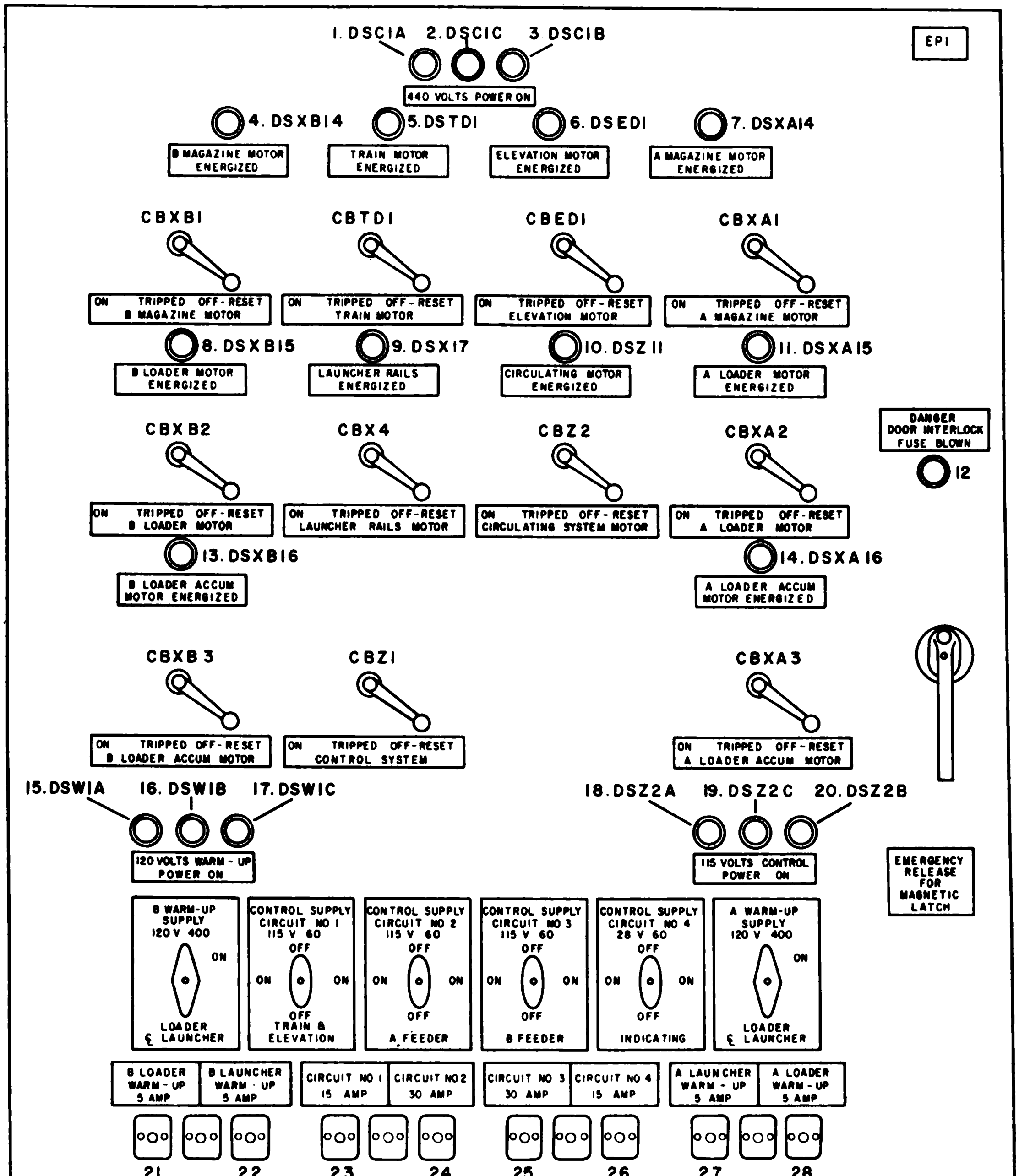
The EP2 panel, located in the aft of the assembly area, contains mode-selector switches, start switches, step control switches with their indications, ready service ring load indications, load order switches, firing status indications, and emergency switches. (The EP2 panel is shown in illustration on page 214.)

The A-side assembly captain's panel EP4 is located in the wing and fin assembly area. This panel contains switches and indications required to control the wing and fin assembly during automatic operations and switches for strikedown and checkout operations. (The EP4 panel is shown in illustration on page 215.)

The B-side assembly captain's panel EP5 is a duplicate of the EP4 panel, except that it operates the B-side.

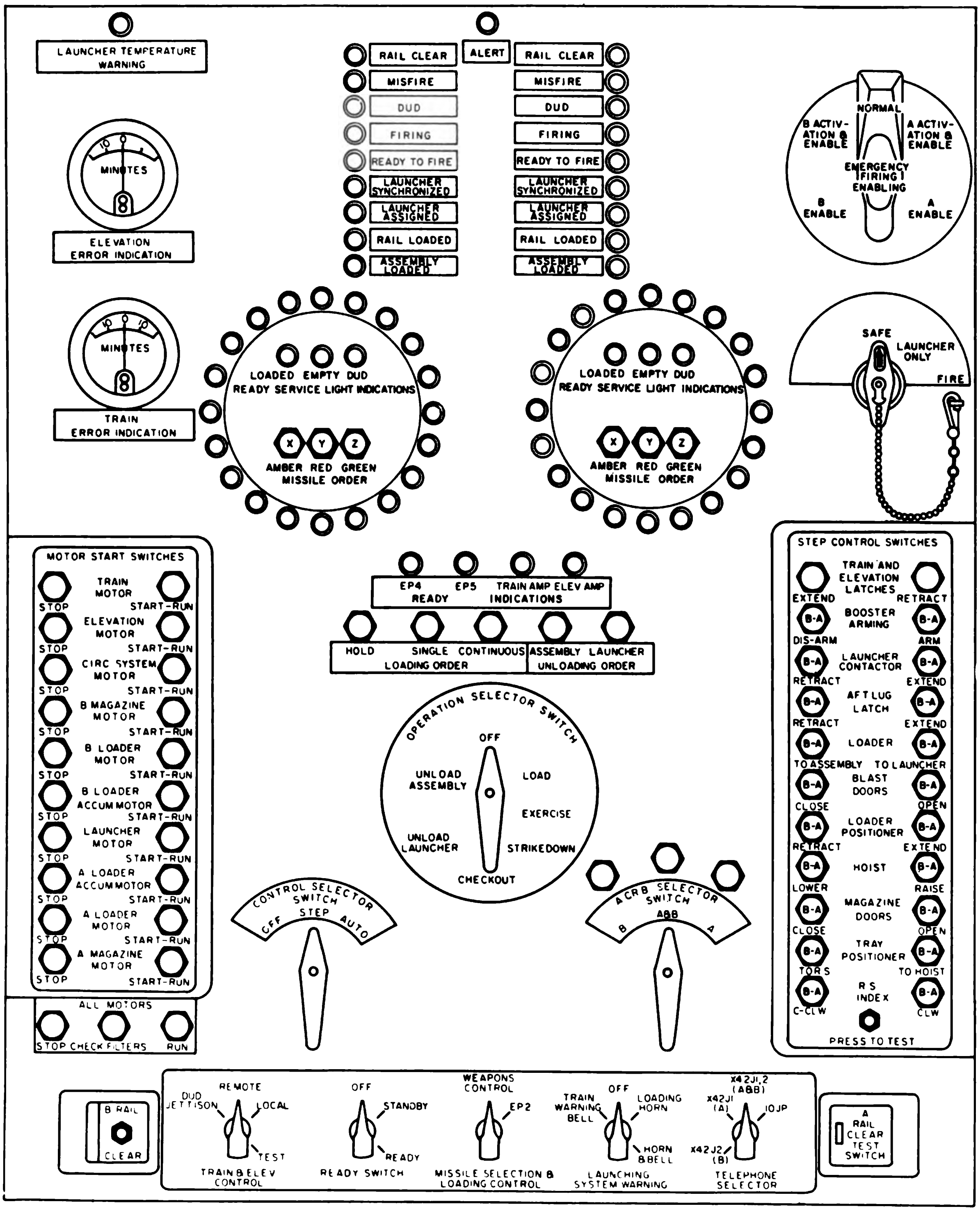
The EP3 panel is located in the checkout area. This panel contains equipment for conducting performance tests on the train and elevation power drive units and is not used during load operations. (The EP3 panel is shown in illustration on page 216.)

The dud jettison panel, located in the checkout area, was explained in Topic 7 of this section.

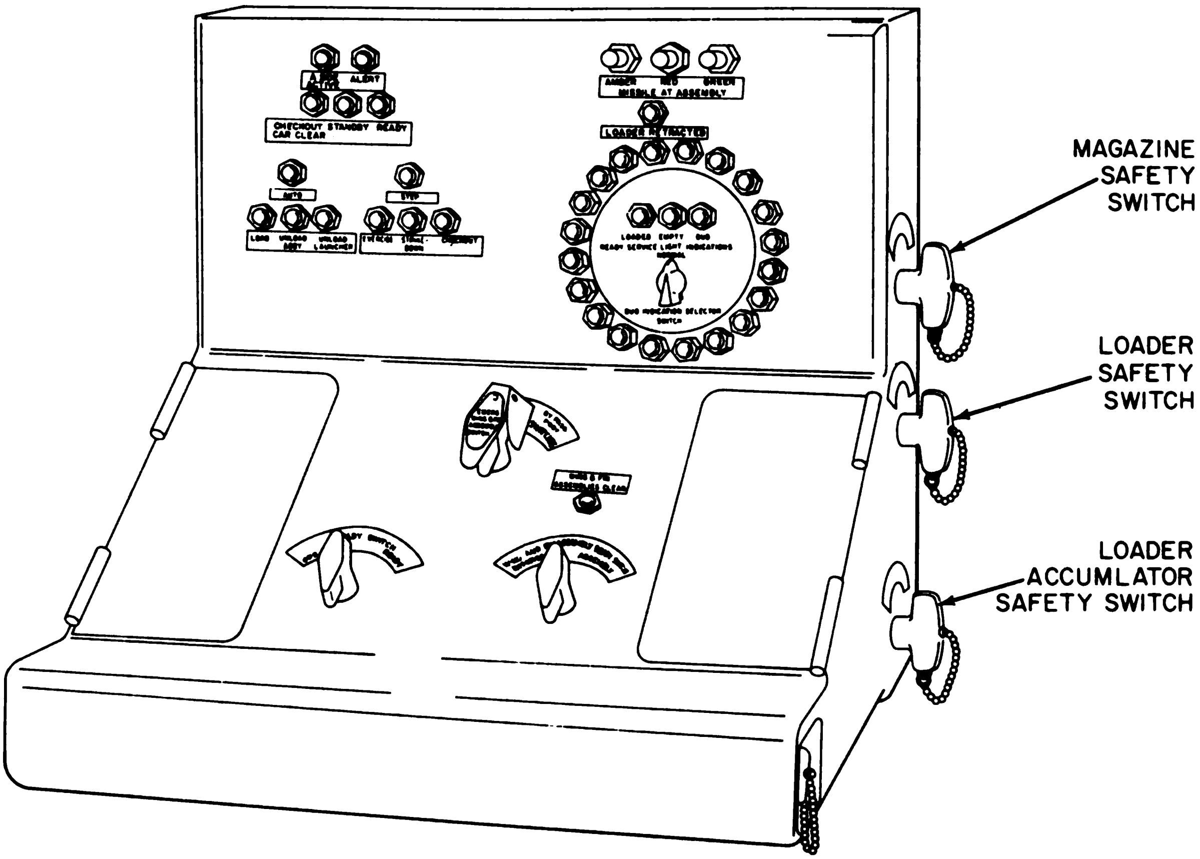

EP1
1. DSC1A
2. DSC1C
3. DSC1B
440 VOLTS POWER ON
4. DSXB14
B MAGAZINE MOTOR ENERGIZED
5. DSTD1
TRAIN MOTOR ENERGIZED
6. DSED1
ELEVATION MOTOR ENERGIZED
7. DSXA14
A MAGAZINE MOTOR ENERGIZED
CBXB1
ON TRIPPED OFF-RESET B MAGAZINE MOTOR
CBTD1
ON TRIPPED OFF-RESET TRAIN MOTOR
CBED1
ON TRIPPED OFF-RESET ELEVATION MOTOR
CBXA1
ON TRIPPED OFF-RESET A MAGAZINE MOTOR
8. DSXB15
B LOADER MOTOR ENERGIZED
9. DSX17
LAUNCHER RAILS ENERGIZED
10. DSZ11
CIRCULATING MOTOR ENERGIZED
11. DSXA15
A LOADER MOTOR ENERGIZED
DANGER DOOR INTERLOCK FUSE BLOWN
12
CBXB2
ON TRIPPED OFF-RESET B LOADER MOTOR
CBX4
ON TRIPPED OFF-RESET LAUNCHER RAILS MOTOR
CBZ2
ON TRIPPED OFF-RESET CIRCULATING SYSTEM MOTOR
CBXA2
ON TRIPPED OFF-RESET A LOADER MOTOR
13. DSXB16
B LOADER ACCUM MOTOR ENERGIZED
14. DSXA16
A LOADER ACCUM MOTOR ENERGIZED
CBXB3
ON TRIPPED OFF-RESET B LOADER ACCUM MOTOR
CBZ1
ON TRIPPED OFF-RESET CONTROL SYSTEM
CBXA3
ON TRIPPED OFF-RESET A LOADER ACCUM MOTOR
15. DSW1A
16. DSW1B
17. DSW1C
120 VOLTS WARM-UP POWER ON
18. DSZ2A
19. DSZ2C
20. DSZ2B
115 VOLTS CONTROL POWER ON
EMERGENCY RELEASE FOR MAGNETIC LATCH
B WARM-UP SUPPLY 120 V 400
ON
LOADER & LAUNCHER
CONTROL SUPPLY CIRCUIT NO 1 115 V 60
OFF ON ON OFF
TRAIN & ELEVATION
CONTROL SUPPLY CIRCUIT NO 2 115 V 60
OFF ON ON OFF
A FEEDER
CONTROL SUPPLY CIRCUIT NO 3 115 V 60
OFF ON ON OFF
B FEEDER
CONTROL SUPPLY CIRCUIT NO 4 28 V 60
OFF ON ON OFF
INDICATING
A WARM-UP SUPPLY 120 V 400
ON
LOADER & LAUNCHER
B LOADER WARM-UP 5 AMP
B LAUNCHER WARM-UP 5 AMP
CIRCUIT NO 1 15 AMP
CIRCUIT NO 2 30 AMP
CIRCUIT NO 3 30 AMP
CIRCUIT NO 4 15 AMP
A LAUNCHER WARM-UP 5 AMP
A LOADER WARM-UP 5 AMP
21
22
23
24
25
26
27
28
SPARE FUSES
SPARE FUSES

NOTE: LIGHTS 1 THROUGH 20 ARE RED. LIGHTS 21 THROUGH 28 ARE WHITE "FUSE-BLOWN" LIGHTS WITHOUT DESIGNATIONS.

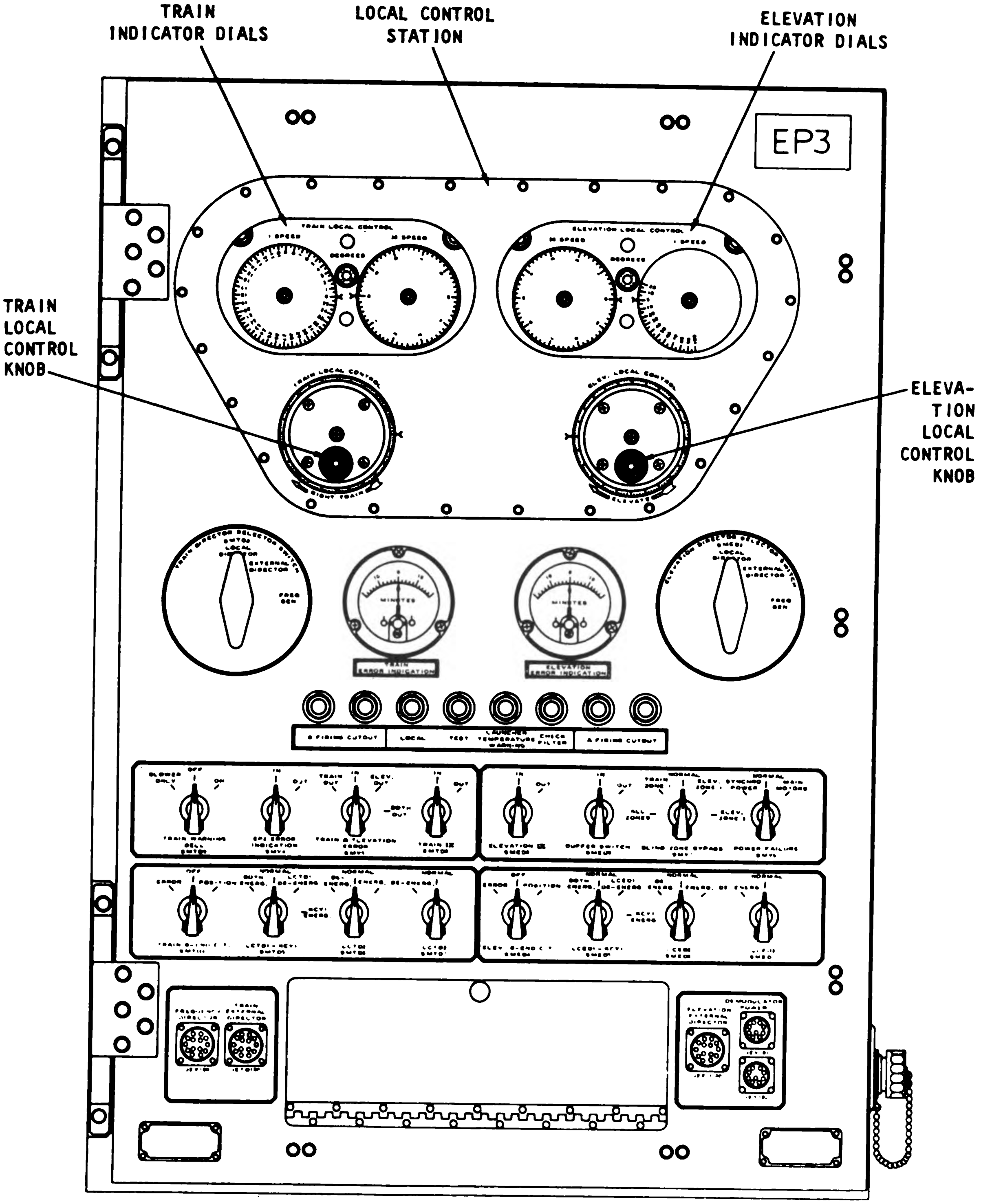
132. POWER SUPPLY PANEL EP1



133. LAUNCHING SYSTEM PANEL MK 190 MOD 0 (EP2)



134. ASSEMBLER PANEL EP4



135. TEST PANEL EP3

TOPIC 9: MISSILE REPLENISHMENT AND STRIKEDOWN

You Are Now Going to Learn:

1. Missile replenishment and strikedown procedures.

Discussion Points for this Topic Are:

1. Replenishing methods.
2. Handling attachments.
3. Transfer dolly operations.
4. Missile booster strikedown procedures.
5. Review and summary.

INFORMATION AND DISCUSSION:

A ship at sea can be loaded with missiles, boosters, and associated components from an ammunition ship (AE). A ship also can be replenished in port from alongside a pier or from a barge.

Transfer at sea may be accomplished by means of the Burtoning method, constant tension highline method, modified housefall method, or by a new method called the fast automatic shuttle transfer (FAST). Only the modified housefall and FAST methods will be described in this topic.

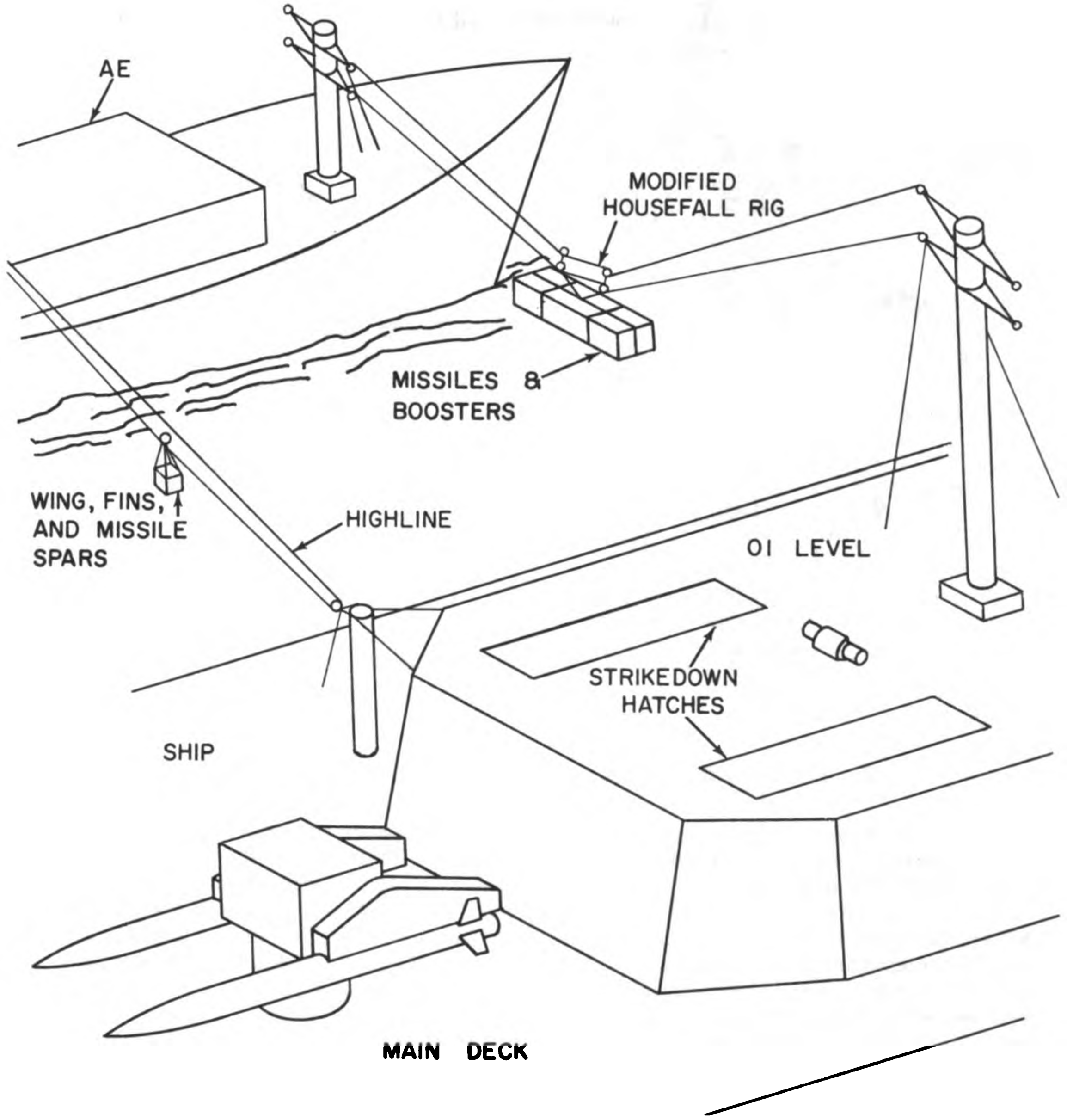
The modified housefall rig, shown in illustration on facing page, transfers from the AE a booster or missile, completely assembled (except for the wings and fins), unpackaged, and suspended in a transfer dolly (grasshopper).

Boosters or missiles arrive on the 01 or 02 level (depending on ship type) atop the deckhouse, near one of the strikedown hatches, at the maximum rate of one every 90 seconds. In order to maintain a simultaneous port and starboard flow, missile booster transfer is scheduled so two boosters are transferred followed by two missiles. Scheduling of missile component transfer is arranged so a balanced group of components will have been transferred in any given time. This is done to insure that components for the greatest number of complete rounds will be onboard the missile ship if the transfer operation must be terminated suddenly. Normally, both port and starboard strikedown hatches are used.

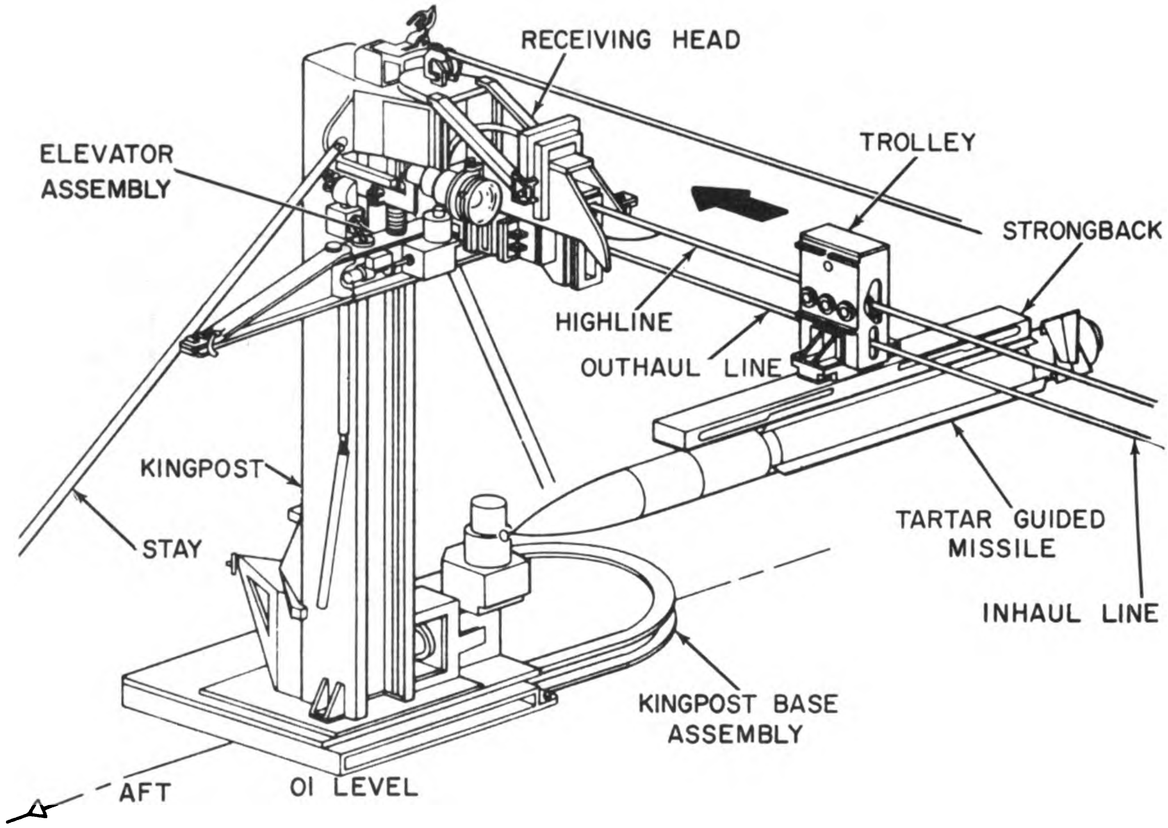
Spare warheads and exercise heads are also transferred on the modified housefall rig.

The highline, shown in illustration on facing page, is used to transfer missile components (wings, fins, spare parts, etc.) concurrently with booster missile transfer.

The FAST method of missile and booster transfer employs a constant tension highline between kingposts on both the AE and missile ships. A trolley, controlled by outhaul and inhaul lines from the AE, transfers the missile or booster, supported in a strongback, to the missile ship. The trolley is engaged and held by a receiving head atop the missile ship kingpost. Then, elevator arms, controlled by a console operator, close to engage the strongback. The trolley is released and returned to the AE to acquire another booster or missile. The FAST elevator then lowers the missile or booster to the missile ship strikedown elevator where the strongback is removed.



136. WEAPON TRANSFER BY MODIFIED HOUSEFALL METHOD

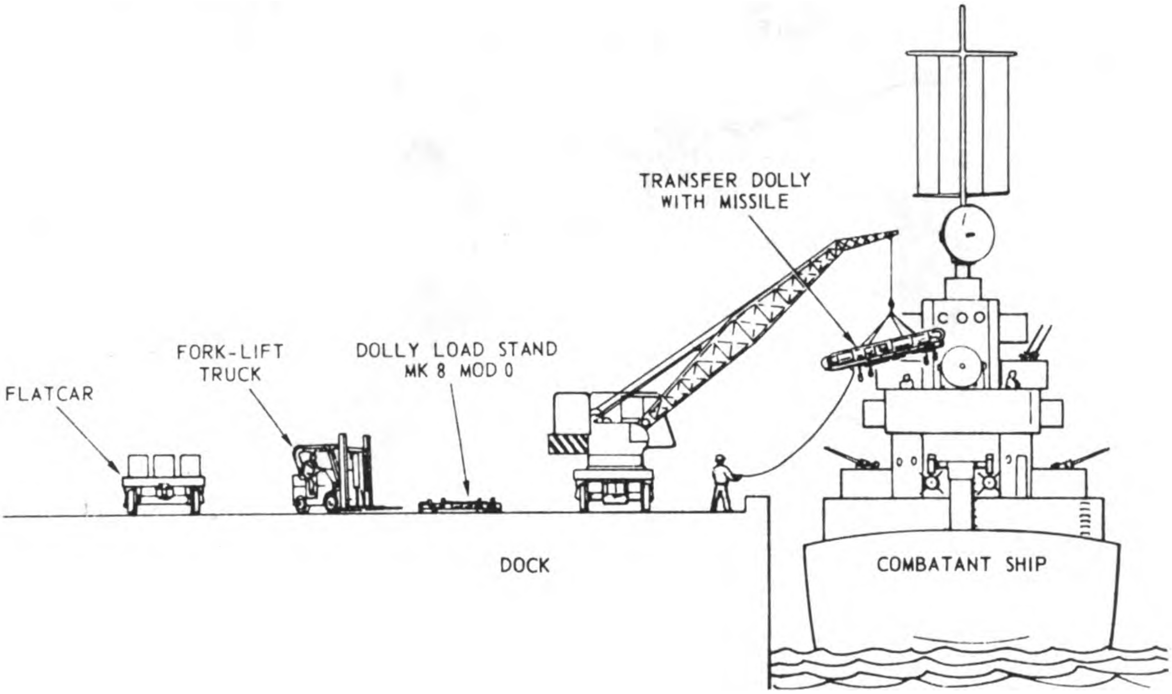


137. TRANSFER OF TARTAR MISSILE BY FAST METHOD

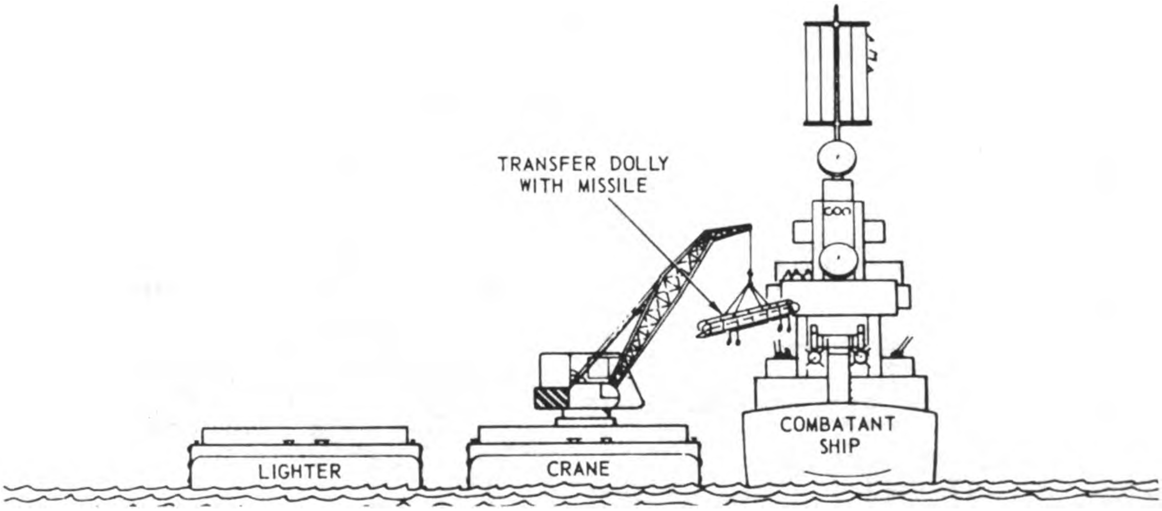
NOTE: This description applies only to Terrier missile launching systems Mk 9 and Mk 10. Tartar launching systems Mks 11, 13, and 22 use the same type of FAST kingpost and elevator, see the above illustration; however, the missile is lowered to a deck fixture (transfer cart). Talos systems Mks 7 and 12 use a different type of kingpost and a boom to lower the missile or booster from the kingpost to the strikedown elevator.

When a missile ship is replenished from a pier or dock, a crane is normally used to lift the booster or missile to the strikedown area as illustrated at the top of the facing page. Each missile and booster is decanned, rotated for strikedown, and loaded into a transfer dolly on the pier. The FAST system can be used only if FAST system equipment is available on the pier.

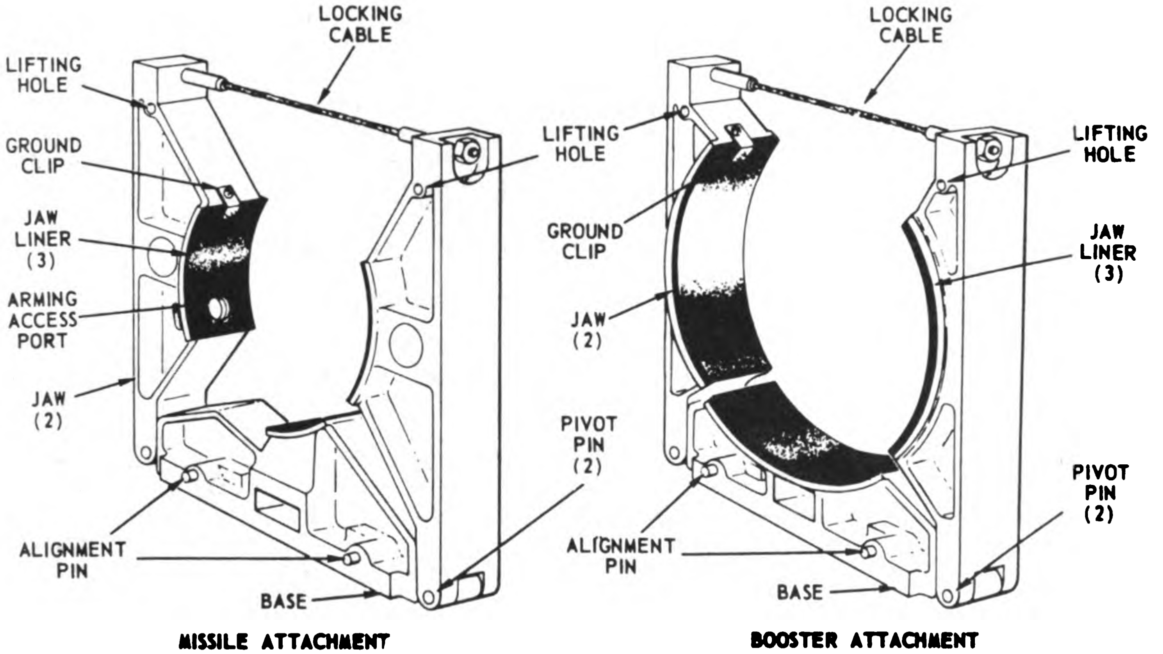
When missiles are replenished from a lighter, as illustrated at the bottom of the facing page, a floating crane is normally used to transfer the missiles or boosters. Each booster and missile is decanned, rotated for strikedown, and loaded onto a transfer dolly aboard the lighter.



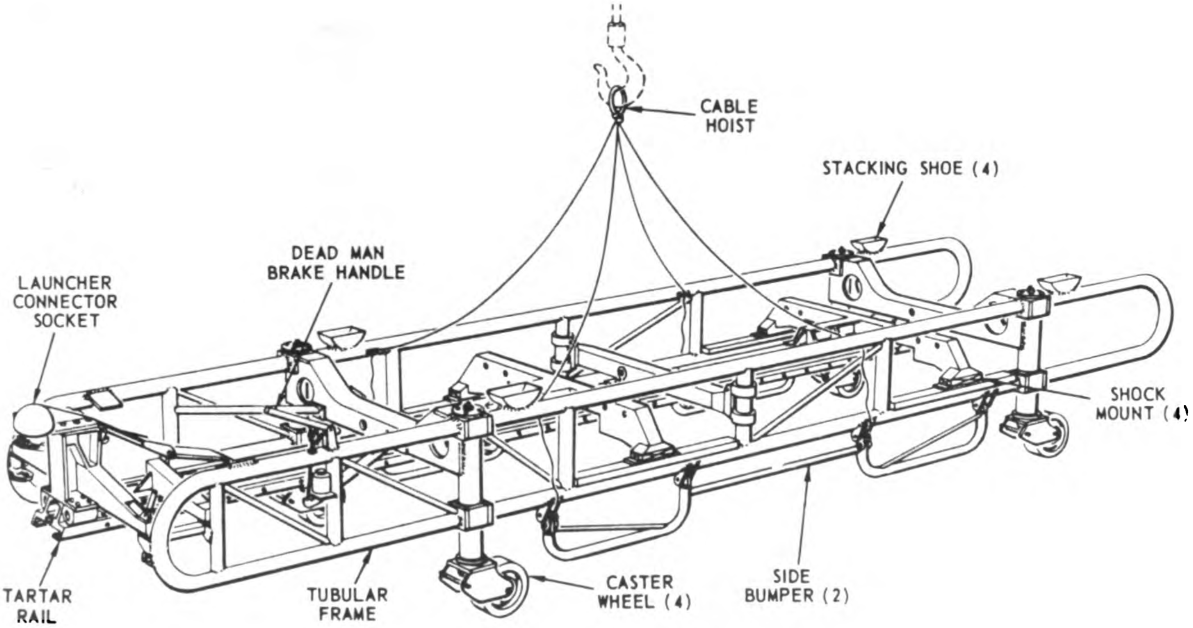
138. DOCKSIDE REPLENISHING



139. REPLENISHMENT FROM A LIGHTER



140. WEAPON HANDLING ATTACHMENTS



141. WEAPON TRANSFER DOLLY

Handling attachments (also called transfer bands) are provided to support the missile and booster during shipment and strikedown. These bands (refer to illustration at top of facing page) consist of a base, two pivoted jaws, and a locking cable. The base and jaws are made of aluminum and fitted with rubber liners to protect the skin of the missile or booster. Two pins in the base provide alinement and support of the missile and booster in their containers. Two holes are also located in the bottom of the base to provide for alinement pins located on the checkout car.

During strikedown, the booster handling attachments remain on the booster until it has been placed on the loader rail, and the missile handling attachments remain on the missile until it has been mated with the booster.

Transfer dolly (grasshopper) Mk 6 Mod 0 is used to support the missile or booster during all modes of transfer except in the FAST method. The dolly also functions to place the missile in the correct position to be received by the strikedown elevator. This transfer dolly handles all types of Terrier missiles, the Terrier booster, and the Tartar missiles.

The dolly shown in the illustration at bottom of facing page, consists of a tubular metal frame, two shock mounted handling attachment holding fixtures (for Terrier missiles and boosters), a Tartar rail adapter, a cable sling, a dead man brake, and caster wheels.

All Talos missile launching systems and Terrier missile launching systems Mk 9 and Mk 10 use a hydraulically operated strikedown elevator to lower the boosters and missiles from the 01 or 02 level into the missile house. A hydraulically operated hatch directly over the elevator must be open before the elevator can be raised. The hatch is automatically closed as soon as the elevator is clear during lowering.

On the Mk 9 and Mk 10 Terrier missile launching systems, a checkout car is used to remove the booster from the elevator and position it in a rail in preparation for mating. The car then removes a missile from the elevator and positions it so that the booster and missile can be mated. After mating, the assembled weapon is transferred to the magazine hoist by the rail.

NOTE: More details on the checkout car and mating will be provided in Topic 10 of this section.

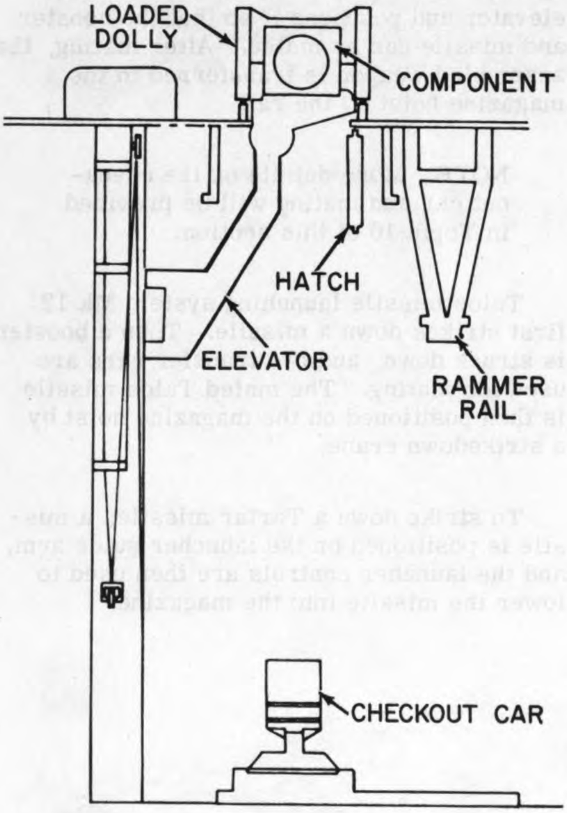
Talos missile launching system Mk 12 first strikes down a missile. Then a booster is struck down, and two transfer cars are used for mating. The mated Talos missile is then positioned on the magazine hoist by a strikedown crane.

To strike down a Tartar missile, a missile is positioned on the launcher guide arm, and the launcher controls are then used to lower the missile into the magazine.

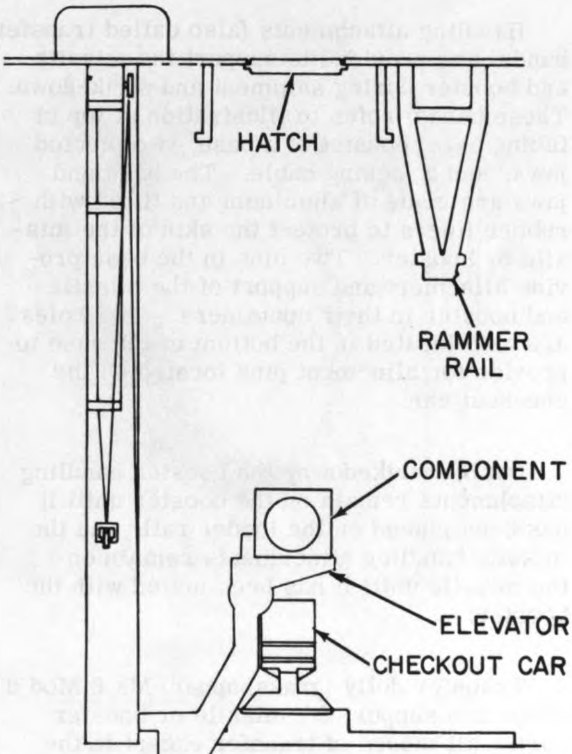
The following is a brief description of the GMLS Mk 10 strikedown procedure:

1. When a booster is in proper position above the strikedown hatch, an operator at a control station on the 01 level and an operator at the elevator control station in the checkout area simultaneously depress their control pushbuttons, to open the hatch and to raise the strikedown elevator.

2. When the elevator has reached its upper position, it receives a booster from the transfer dolly or FAST elevator, as shown below.



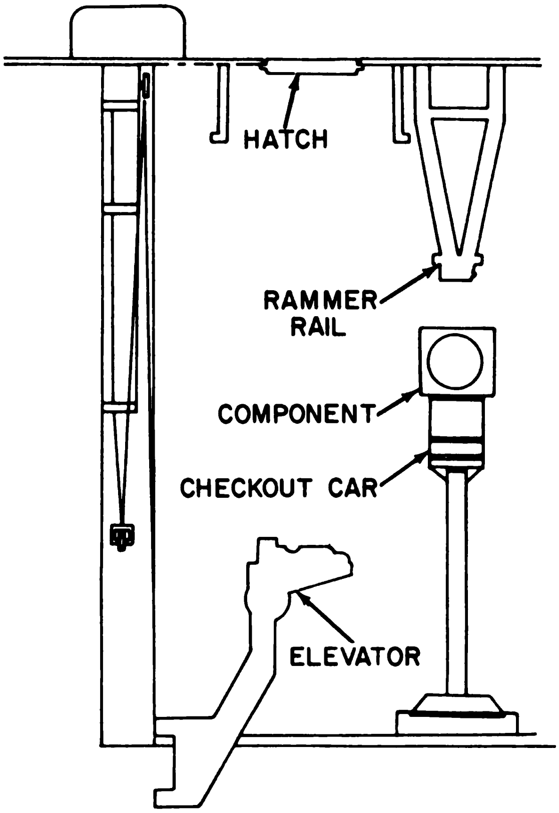
142. STRIKEDOWN OPERATIONS, ELEVATOR RAISED



143. STRIKEDOWN OPERATIONS, CHECKOUT CAR TO ELEVATOR

3. The elevator is lowered by the operators depressing their Lower pushbuttons. As the elevator passes through the strikedown hatch, the hatch door automatically closes.

4. The elevator carrying a booster stops in the checkout area with the booster suspended just above the checkout car table as shown above. The checkout car operators move the car into proper position under the booster. The car table then is raised to receive the booster from the elevator.



144. STRIKEDOWN OPERATIONS, CHECKOUT CAR TO RAMMER RAIL

5. The checkout car operators, by means of the car controls, bring the booster into proper alinement with the loader rail, as shown in the adjacent column.

6. The loader engages the booster shoes and moves the booster clear of the strikedown area.

7. To position a missile on the checkout car, steps 1., 2., 3., and 4., are repeated with the missile.

8. The car is then positioned so that the missile is in the proper position for mating.

9. The loader returns the booster into the strikedown area, and mating is accomplished.

10. The mated weapon is positioned over the magazine hoist by the loader and then lowered into the magazine.

TOPIC 10: MISSILE HANDLING, CHECKOUT, SERVICING, AND MAINTENANCE

You Are Now Going to Learn:

1. Introduction to missile handling, checkout, servicing, and maintenance.
2. BT3 Terrier missile handling, checkout, servicing, and maintenance.

You Will Acquire Skill in:

1. Mating and unmating a BT3 Terrier missile.

Discussion Points for this Topic Are:

1. Responsibility of the GMM in connection with the missile.
2. Shipboard missile checkout.
3. Shipboard missile checkout stations.
4. Missile test sets.
5. Shipboard missile component replacement.
6. Shipboard missile servicing.
7. BT3A Terrier missile mating and unmating.
8. BT3A Terrier missile checkout.
9. BT3A Terrier missile warhead exchange.
10. Review and summary.

INFORMATION AND DISCUSSION:

The gunner's mate (GMM) assigned to a guided missile launching system is responsible for the handling, custody, and care of the missiles used by that system. This responsibility includes the following tasks:

1. Mating/unmating.
2. Warhead and exercise head exchange.
3. Assembly and disassembly.
4. Preparation of missile for tests.
5. Missile servicing (preventive maintenance.

Gunner's mates are not responsible for performing the missile system tests or for the test equipment. These responsibilities belong to the missile technician. It is necessary for the GMM to mate (join the booster and missile) all Terrier and Talos missiles during strikedown and to unmate these same missiles during strikeup (off loading). The task of mating and unmating must also be performed every time these missiles are tested (checked out) and whenever it is necessary to change warheads or install exercise heads.

As soon as practical after the missiles have been brought aboard ship, a missile system test (MST), commonly called missile checkout, must be performed. Thereafter, periodic checkouts will be conducted at intervals established by the Bureau of Naval Weapons. For example, BUWEPS at the time of this writing requires that BT3 Terrier missiles be checked at 30 day intervals for the first three times and at 90 day intervals subsequently.

Both initial and periodic tests are conducted in areas (stations) especially provided with missile component handling equipment and test sets. The exact locations of missile checkout stations vary in many launching systems. However, except for the Tartar missiles which are checked out on a launcher guide arm, the checkout area is normally located in the missile house, outboard of the loaders, in or near the strikedown and mating area.

Special guided missile test sets (GMTS) have been developed for each type of missile. These test sets program the missile through a simulated flight sequence, comparing missile response to known standards. The final result of the test is a GO or NO-GO indication of missile condition. A GO indication means that the missile is flight-ready, and a NO-GO indication means that the missile has failed the test. The NO-GO (fault) lights involved indicate which component or components in the missile should be repaired or replaced.

NOTE: The term component here means a part or group of parts (package) of a missile which, by design or construction, lends itself to a unit concept of replacement or repair.

Missile components are not normally repaired aboard ship. When the test set indicates that a missile component is defective, a new component is installed by the GMM and the missile is retested.

In order to replace faulty missile components, it is normally necessary to disassemble a portion of the missile. The amount of disassembly necessary depends on the faulty components and on the missile type. Terrier and Talos missiles are disassembled and reassembled while they are on the checkout car with the aid of special tools, handling attachments, and an overhead crane. Tartar missile defective components are removed while the missile is on the launcher guide arm with the aid of special tools, handling attachments, a handling kingpost, and a handling hoist.

Shipboard missile servicing (preventive maintenance) consists of a series of systematic inspections, checks, and servicing operations performed at regular intervals. The frequency and type of servicing performed vary on each type of missile. For example, the Talos 6C1 missile must have its battery removed and a reconditioned replacement installed every month. The Talos also must have its fuel, hydraulic, and nitrogen systems checked bimonthly. In comparison, the Terrier BT3A missile requires no special servicing under normal conditions. However, the hydraulic system on this missile (BT3A) requires filling after component replacement procedures which necessitate breaking into the hydraulic system. The fluid level of the hydraulic system on the BT3A also must be checked after each checkout.

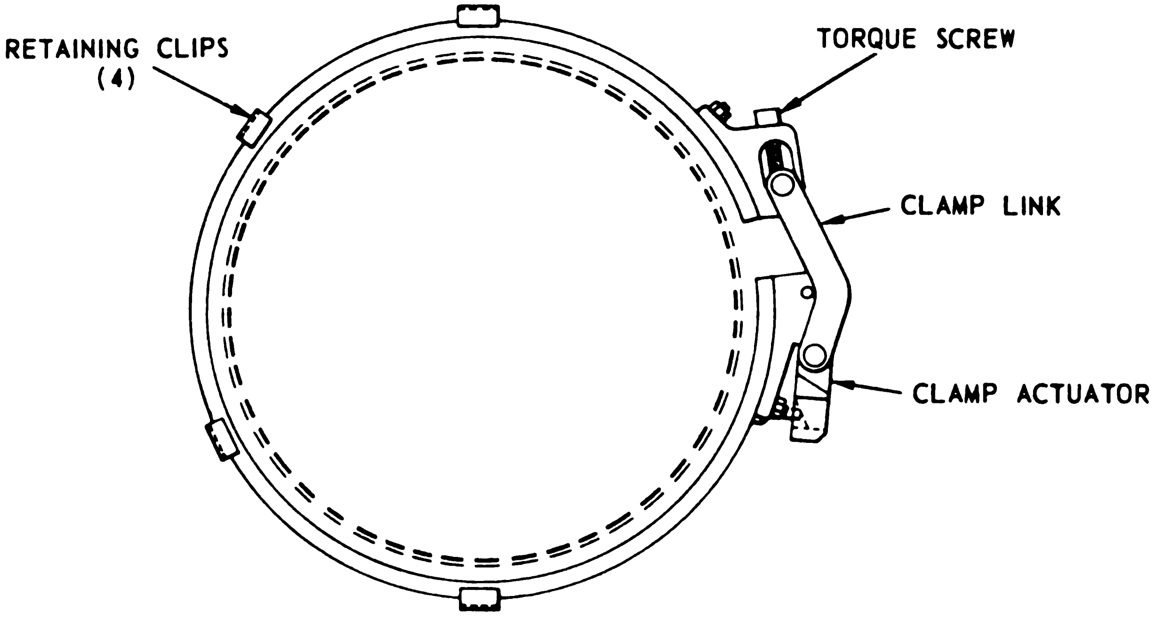
Unless otherwise noted, the remainder of this topic will briefly describe the shipboard procedures for Terrier BT3A missile mating, unmating, checkout, and component replacement. To simplify this text, only GMLS Mk 10 handling equipment will be described.

In preparation for missile checkout, missile servicing, warhead exchange, or exercise head installation, the assembled missile must be unmated. Before unmating, the following step by step tasks must be performed:

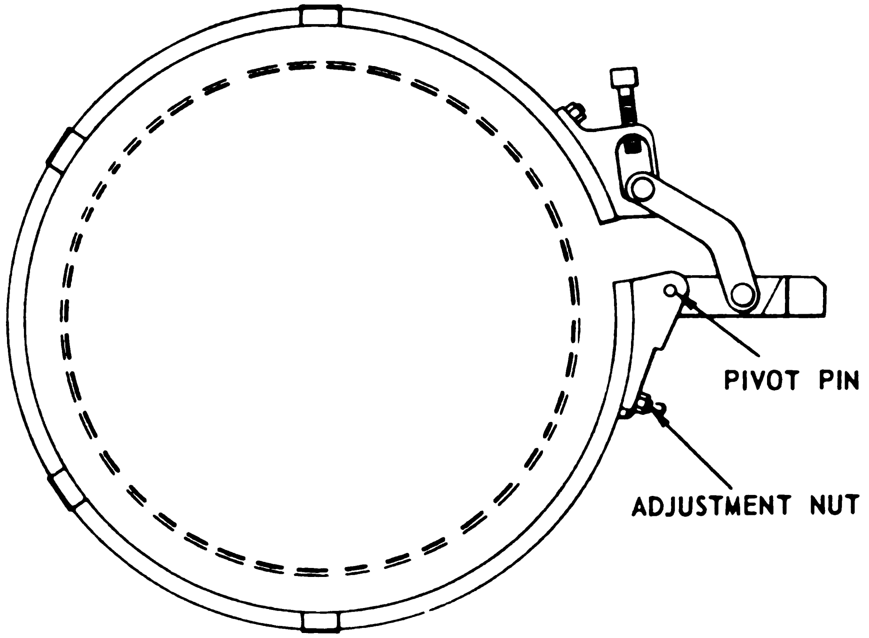
1. Transfer of the mated weapon from the magazine to the checkout area (stop No. 1).
2. Moving of the checkout car inboard under the missile.
3. Moving of the car table to its aft position (towards booster).
4. Positioning of standard missile handling attachments on the car.
5. Raising of the car table to the missile.
6. Fastening on the handling attachments to the missile.

NOTE: The handling attachments should be tightened (torqued) enough to prevent the missile from moving during mating and unmating but not to exceed a value of 660±30 in. -lbs.

To separate the missile from the booster, fully loosen the booster suitcase latch torque screw, and unlock the suitcase latch by inserting a handle in the clamp actuator to lift it upward. (The suitcase latch assembly is shown in illustration on page 228.) With the suitcase latch fully open, the booster is separated from the missile by moving the checkout car table away from the booster.



A - BOOSTER SUITCASE LATCH FULLY CLOSED, LOOKING AFT



B - BOOSTER SUITCASE LATCH FULLY OPEN, LOOKING AFT

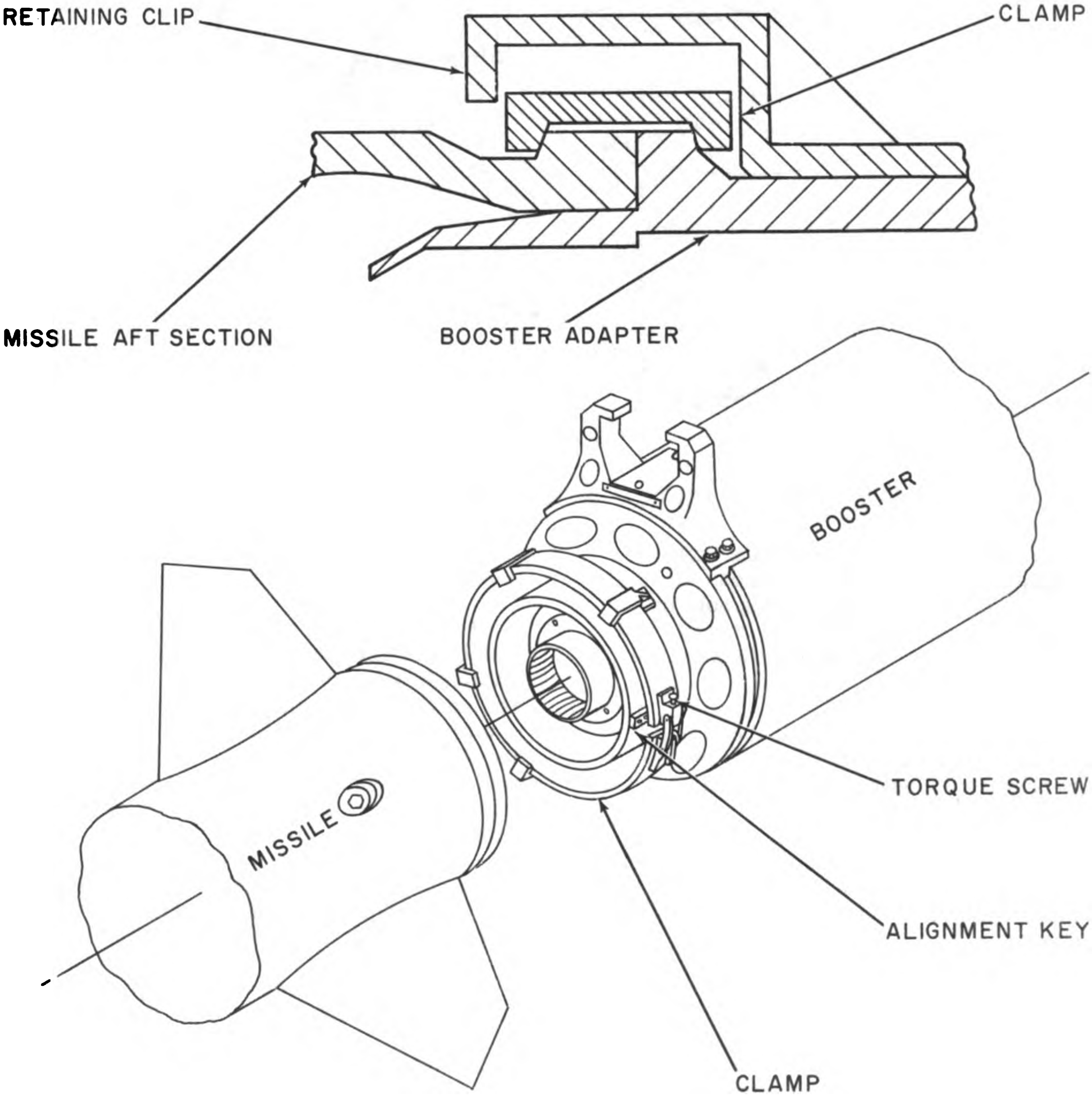
145. MISSILE BOOSTER RELEASE MECHANISM (SUITCASE LATCH)

To remate the booster and missile, move the booster into the checkout area (stop No. 1), then position the checkout car so that the missile is in the approximate mating position and proceed with the following steps:

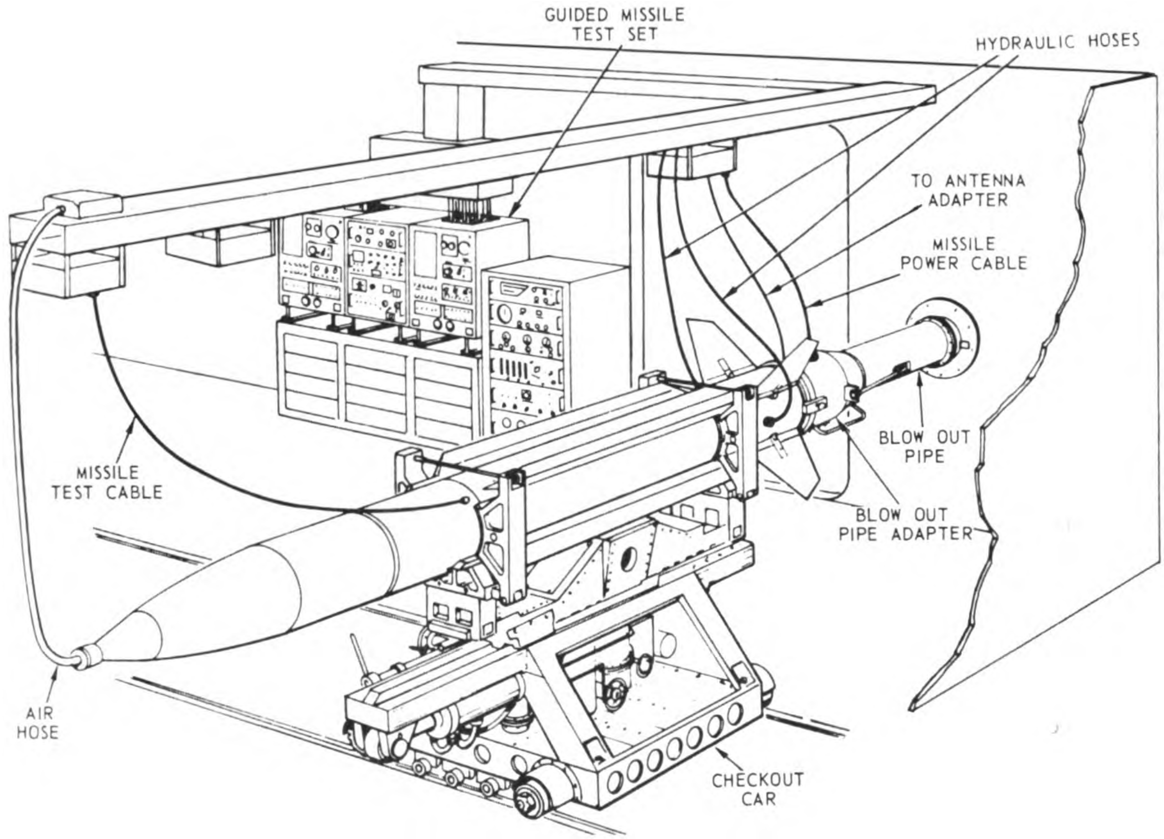
1. Check that the torque screw is fully loosened and that the suitcase latch is open.

2. Install the missile booster alinement insert in the missile booster electrical contactor.

3. Carefully aline the missile, by use of the checkout car controls, until the keyways of the missile are alined with the booster alinement lugs (keys), shown in illustration below. Then slowly move the missile into firm engagement with the booster.



146. BT3A MISSILE BOOSTER MATING JOINTS



147. TYPICAL SHIPBOARD MST STATION INSTALLATION

4. After checking to insure that the adjustment nut is fully tightened, insert the clamp actuator handle into the hole in the clamp actuator, and lock the missile and booster together by closing the suitcase latch.

5. Check to insure that the clamp link is making contact with the pivot pin (refer to part A of illustration on page 228) but not contacting the adjusting nut.

6. Remove the clamp actuator handle and tighten the torque screw to 480±60 in.-lbs., using a torque wrench and special hex adapter.

7. Insert a drift pin, scribe, or similar tool, into the hole in the shaft under the adjusting nut. Holding the shaft stationary, loosen the adjustment nut until it makes contact with the clamp actuator. When contact is made, back off an additional 1/4 turn, and recheck the clamp link to insure that it is still in contact with the pivot pin.

If the missile is to be tested, the car with the unmated missile is lowered, moved outboard, and locked at the checkout station. The aft end of the missile is then connected to a blowout pipe with the use of an adapter, shown in illustration above. The blowout pipe is built into the ship and exhausts overboard in the event of accidental sustainer ignition during tests.

To complete the preparation of the missile for a shipboard test, perform the following tasks:

1. Install a microwave adapter to the blowout pipe adapter.

2. Install telemetering antennas in dorsal fins No. 2 and No. 4 (used only during testing of missiles with exercise heads).

3. Remove the nose probe shield.

4. Unfold the control surfaces.

5. Remove the forward end of dorsal fin No. 1 (to uncover the test receptacle).

6. Remove the access covers from the hydraulic pressure and return ports.

7. Insure that all grounding leads are properly attached.

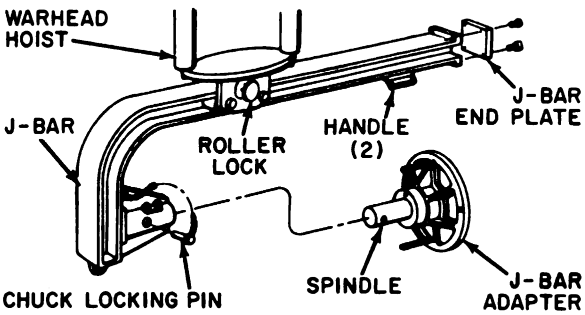
8. Attach the hoses and cabling to the missile.

The actual MST will be conducted by a missile technician. After the test is completed, a good (GO indication) missile will be mated and returned to the magazine. However, should the missile be defective (NO-GO indication), it will be either mated and returned to the magazine as a dud or repaired (defective component replaced) immediately and retested. The decision of whether to return the NO-GO missile to the magazine or to repair it depends upon ship's doctrine and the tactical situation.

When it becomes necessary to exchange warheads, the missile is removed from the magazine, unmated, and moved by the checkout car to the checkout area where interchange is performed with the use of the checkout area handling equipment. Before removing the warhead, it is necessary to install the warhead handling J-bar to the warhead hoists. This is accomplished by temporarily removing the J-bar end plate and engaging the J-bar slot with the hoist rollers, as shown in illustration in the adjacent column.

To remove the warhead, use the following step by step procedures:

1. Remove the missile nose section, fuze section (target detecting device or TDD), and the safe and arm (S & A) device.



148. WARHEAD HANDLING J-BAR

NOTE: The procedures for disassembly of these missile sections are described later in this topic.

2. Remove the J-bar adapter from the J-bar and attach it to the warhead flange by rotating the adapter until the adapter pin is engaged, approximately 1/6 turn.

3. Position the warhead hoist so that the J-bar can be engaged with its adapter, and lock by inserting the chuck locking pin.

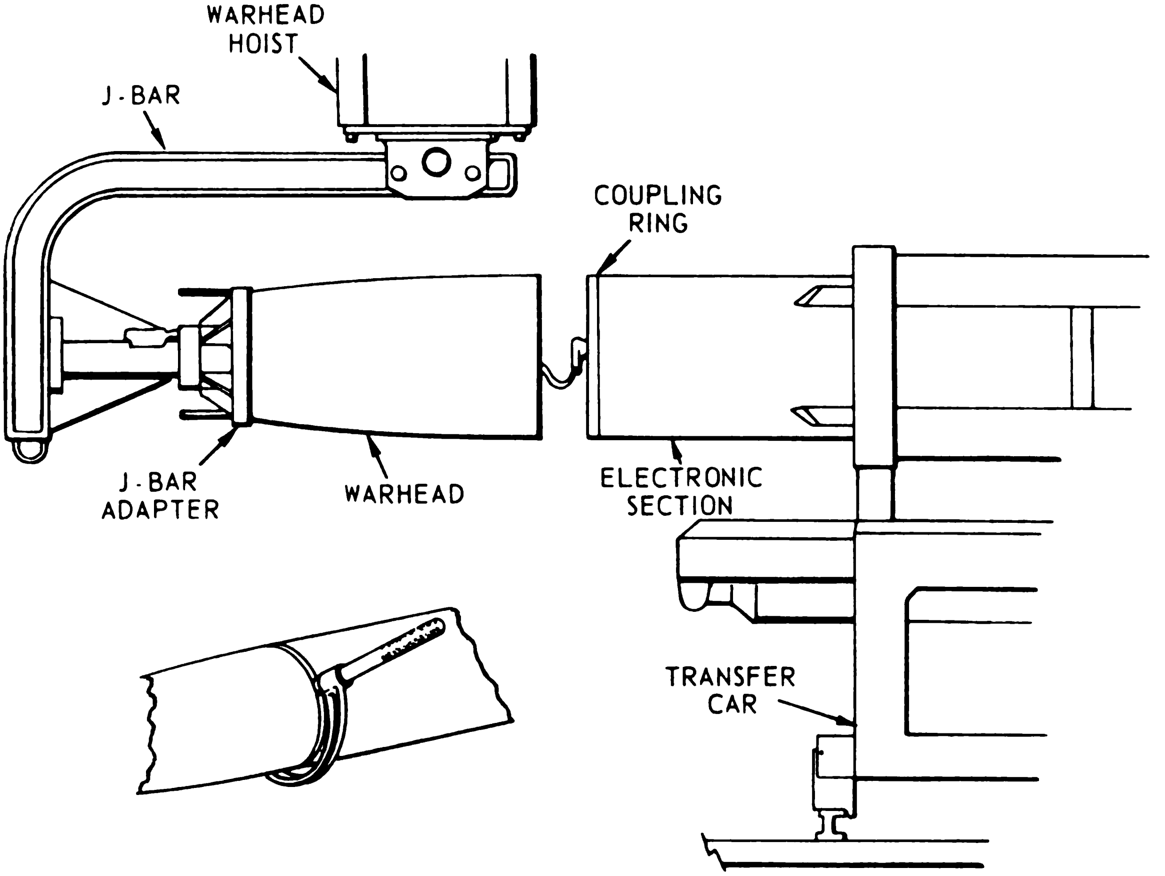
4. Move the hoist until the hoist rollers are at the indicated proper position for warhead removal and lock the J-bar to the hoist. Raise the hoist to remove any slack between the hoist, J-bar, and missile warhead.

5. Unlock the warhead from the electronic section by using a spanner to rotate the coupling (locking) ring.

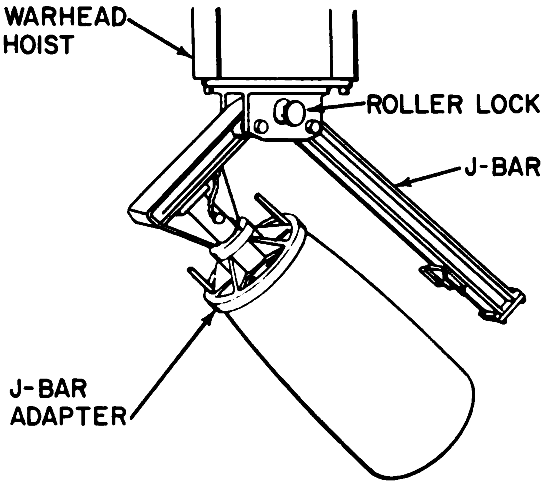
6. Separate the warhead and electronic section 3 to 4 inches and disconnect the electrical connector (refer to illustration on following page).

7. Move the hoist to position the warhead in a clear area, to permit moving the warhead from a horizontal to a vertical position.

8. Position personnel at both sides of the warhead to restrain the warhead and



149. WARHEAD SEPARATION



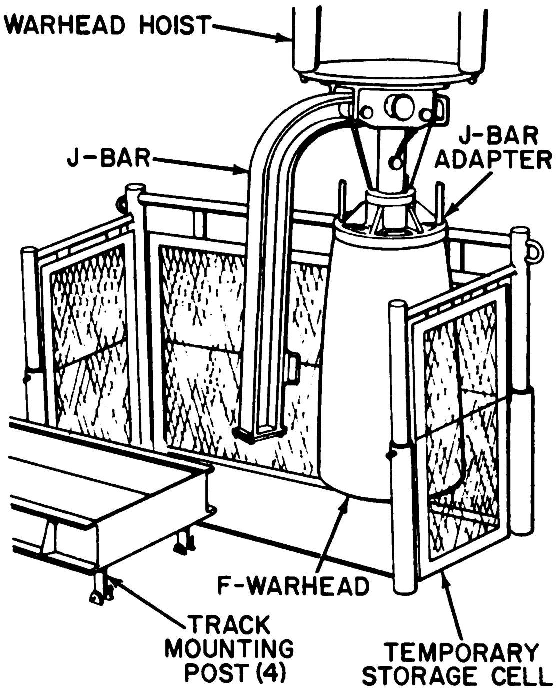
150. WARHEAD SHIFTING TO THE VERTICAL POSITION

prevent a sharp whip when the hoist rollers pass around the curved portion of the J-bar, as illustrated in the adjacent column.

9. Unlock the J-bar and carefully roll it along the hoist rollers until the warhead is in a vertical position.

10. Lock the J-bar to the hoist, and move the hoist to a point above the temporary stowage cell as shown in the illustration on facing page. Carefully lower the warhead into the cell, and disconnect the J-bar adapter.

Assembly of a replacement warhead is essentially the reverse of disassembly.



151. WARHEAD TEMPORARY STORAGE CELL

TOPIC 11: OTHER GUIDED MISSILE LAUNCHING SYSTEMS

You Are Now Going to Learn:

1. Introduction to other types of missile launching systems.
2. Comparison of various types of missile launching systems.

Discussion Points for this Topic Are:

1. Reason for having various types of missile launching systems.
2. Arrangement of major missile launching system components.
3. Terrier Missile Launching System Mk 4.
4. Terrier Missile Launching System Mk 9.
5. Terrier Missile Launching System Mk 10.
6. Talos Missile Launching System Mk 7.
7. Talos Missile Launching System Mk 12.
8. Tartar Missile Launching System Mk 11.
9. Tartar Missile Launching System Mk 13.
10. Tartar Missile Launching System Mk 22.
11. Review and summary.

INFORMATION AND DISCUSSION:

The overall configuration of a missile launching system is determined by the type of missile to be used and the class of ship the system will be installed on.

The missile type is the most important factor to be considered: It is quite obvious that each missile type requires a different launching system.

The types of launching systems, however, are designed for special ships. For example, the Tartar Launching System Mk 22 was designed to replace a 5"/54 caliber gun mount.

The arrangement of major launching system components which handle the same missile type may differ, but basically each launching system performs the same functions. The magazine arrangement is a good example of design differences between launching systems: All three Terrier systems use magazines of entirely different designs.

In the remainder of this topic, various types of GMLS will be briefly described; the different modifications of the various systems, however, will not be covered in this topic.

The Terrier Launching Systems Mk 4 are installed aboard the CAG's: USS Boston and the USS Canberra. Two launching systems are installed on the aft end of each CAG.

The Mk 4 system is different from other systems (except for the Tartar system) in that it uses a vertical feeder system. The dual arm launcher is located over the magazine and loader and therefore is loaded with the guide arm in vertical position (90°).

The Terrier Launching Systems Mk 9 are installed aboard three CLG's: USS Providence, USS Topeka, and USS Springfield. The entire feeder system is located aft on the main deck and is enclosed by a deckhouse.

Two horizontal cell type magazines are used for missile stowage. A transfer car extracts the missiles from the cells and positions them on the rammer (loader) rail.

The assembly area is located in the missile house, near the launcher. The strikedown and checkout area of this system is located outboard of the assembly area. A horizontally loaded dual arm launcher is located on the main deck aft of the missile house.

The Terrier Launching System Mk 10 is used on nearly all classes of missile ships. (The Mk 10 system was described in Topics 1 through 9 of this Section.)

The Talos Launching System Mk 7 is installed on the CLG's: USS Galveston, USS Little Rock, and USS Oklahoma. This system is equipped with a horizontal feeder system and a dual arm launcher. The missiles are stowed in ready service rings and in a replenishing magazine. This launching system is located on the aft part of the ship.

The Talos Launching System Mk 12 is used on CG and CGN class ships. The system is located on both the forward and aft ends of CG class ships and on the aft end of CGN class ships. Except for the dual arm launcher, the system is enclosed in a deckhouse. The magazine portion of the feeder is located below the main deck. There are two tiers of trays for each side (A and B) in which the missiles are stowed. The assembly area is located near the launcher.

The Tartar Launching System Mk 11 is used on DDG and CG class ships. This system is equipped with a dual arm launcher, located over two rings of vertically stowed missiles. The blast doors, installed in a trainable magazine cover, provide a passage for the missile to be hoisted onto the launcher guide arms.

When the launcher is at the LOAD position (90°), a hydraulically driven rammer chain, located in the guide arms, extends into the magazine to extract the missile. All Tartar launchers unfold (erect) the missile fins automatically.

The Tartar Launching System Mk 13 is used on small ships. This system has a single launcher guide arm that loads in the vertical position (90°). The missiles are stowed vertically in two rotatable ready service rings.

The Tartar Launching System Mk 22 was developed for use on small ships where space and weight required a smaller and lighter system than the GMLS Mk 13. The Mk 22 system is designed so that it can replace a 5"/54 caliber gun mount. A single, fixed ready service ring with vertically stowed missiles is located directly below the launcher. The launcher of the Mk 22 system is similar to the one used with the GMLS Mk 13.

QUIZ SHEET:

1. List the three major units that a GMLS can usually be divided into:

a.______________________________.
b.______________________________.
c.______________________________.

2. Normally, the wings and fins are assembled to a missile in one of the following areas:

a. Strikedown.
b. Magazine.
c. Assembly.
d. Checkout.

3. Which one of the following systems aims the launcher during firing?

a. Weapons direction system.
b. Missile fire control system.
c. Weapons control system.
d. Feeder system.

4. In GMLS Mk 10 Mod 0, missiles are warmed up on the launcher and in the assembly area.

True__________or False__________.

5. The GMLS Mk 10 Mod 0 test panel is located in the assembly area.

True__________ or False__________.

6. Which of the following magazine RSR bearing assemblies are driven by a hydraulic motor?

a. Forward and aft.
b. Forward and center.
c. Center and aft.
d. Upper and lower.

7. During a load cycle, a missile booster combination is transferred directly from the tray to one of the following GMLS Mk 10 components?

a. Loader.
b. Hoist.
c. Ready service ring.
d. Positioner.

8. During a GMLS Mk 10 load cycle, which one of the following loader mechanisms moves a missile from the hoist to the loader?

a. Positioner.
b. Contactor.
c. Floating tracks.
d. Retractable rails.

9. When the GMLS Mk 10 blast doors are hydraulically opened, the mechanical linkage causes the spanning rail to extend.

True________ or False____________.

10. List the main components located in a GMLS Mk 10 launcher guide arm.

a.______________________________.
b.______________________________.
c.______________________________.
d.______________________________.
e.______________________________.

11. While the missile is on the GMLS Mk 10 launcher guide arm, warmup is applied to the missile by one of the following components:

a. Aft shoe latch.
b. Arming device.
c. Firing contacts.
d. Launcher contactor.

12. The GMLS Mk 10 launcher forward restraining latch is hydraulically released.

True________or False____________.

13. The launcher slip ring assembly Mk 4 Mod 2 eliminates the cables that could be twisted when the launcher is being trained.

True________or False____________.

14. Which of the following is considered to be the primary mode of control for the launcher Mk 5?

    a. Remote.
    b. Local.
    c. Dud jettison.
    d. Load order.

15. The clinometer is used to observe the angle of ship roll, to determine when it is safe to jettison a missile from the Mk 5 launcher.

    True__________or False____________.

16. Which one of the following panels is used for performing equipment tests on the GMLS Mk 10?

    a. EP1.
    b. EP2.
    c. EP3.
    d. EP4.

17. In which of the following transfer methods is a transfer cart not used to support the booster and missile?

    a. Burtoning method.
    b. Constant tension highline method.
    c. Modified housefall method.
    d. FAST method.

18. When missiles are being transferred from a pier or dock to a missile ship, the FAST system is used only if the ship is equipped with a FAST kingpost.

    True__________or False____________.

19. In which of the following GMLS's is the missile struck down before the booster?

    a. Mk 9.
    b. Mk 10.
    c. Mk 11.
    d. Mk 12.

20. The GMLS Mk 13 uses a dual arm launcher.

    True__________or False____________.

21. The GMLS Mk 4 is the only Terrier system which uses a vertical feeder system.

    True__________or False____________.

22. Which one of the following GMLS uses horizontal cells to stow missiles in?

    a. Mk 7.
    b. Mk 9.
    c. Mk 10.
    d. Mk 11.

23. Which one of the following tasks associated with a missile is not the responsibility of a GMM?

    a. Mating.
    b. Missile servicing.
    c. Component replacement.
    d. Performance of MST.

24. Normally, missile components are repaired aboard ship.

    True__________or False____________.

25. The BT3A Terrier missile control surfaces must be unfolded before an MST is conducted.

    True__________or False____________.

26. After battery charging, how many hours of degassing are required for the batteries in a BT3A exercise head?

    a. 3.
    b. 8.
    c. 12.
    d. 16.

27. The BT3A Terrier missile nose section is secured to the fuze section by a locking ring assembly.

    True__________or False____________.

Accuracy of notes checked by instructor:

Date______________________________

Trainee's initials______________________

TOPIC 12: ASW MISSILE WEAPON SYSTEM

You Are Now Going to Learn:

1. Antisubmarine warfare (ASW).
2. ASROC weapon system components.
3. Location, function, and general arrangement of the major components of the Launching Group Mk 16.

Discussion Points for this Topic Are:

1. Mission and importance of antisubmarine warfare (ASW).
2. Submarine detecting equipment.
3. Underwater battery fire control (UBFC) system.
4. Antisubmarine weapons.
5. Purpose and arrangement of Launching Group Mk 16.
6. General arrangement of the Launcher Mk 112 components.
7. Launcher stand.
8. Launcher carriage.
9. Power Control Panel Mk 198.
10. Launcher Captains Control Panel Mk 199.
11. Loader crane.
12. Review and summary.
13. Section review.
14. Written test.

INFORMATION AND DISCUSSION:

The basic mission of antisubmarine warfare (ASW) is to deny the enemy effective use of their submarines.

The submarine, as an implement of modern warfare, was used for the first time during World War I in the German U-boat campaign against the Allies. Due to the U-boat blockade, the British were faced by the threat of starvation and came close to losing the war to the Central Powers.

In World War II, approximately 1,500 enemy submarines took a toll of 2,753 allied ships.

No one, of course, can predict exactly what future warfare will be like; but it is evident that the naval forces operating under water will be a major factor in determining who has command of the sea. Therefore, our Navy is investing a lot of money in the research and development of antisubmarine weapon systems and weapons.

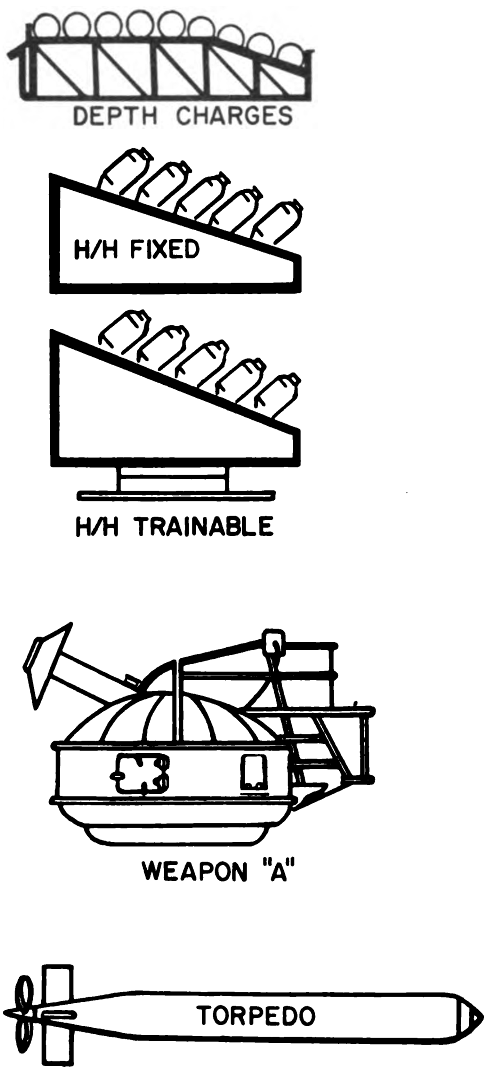
Aboard ship, the main method of detecting and locating submarines is the use of sound waves which travel under water about four times faster than through the air. When these sound waves strike a partially or completely submerged object, part of the sound energy is reflected in the form of an ordinary echo. The equipment that transmits the sound waves and detects the returning echo is called the sound navigation and ranging (sonar) equipment. At present, one sonar system is used to determine target range and bearing, and another (associated) sonar system is used to determine target depth.

Submarines can also be located by means of sonar carrying helicopters and by small, expendable, floating hydrophones called sonar sonobuoy units. A small transmitter in the sonobuoy radio broadcasts a signal to indicate when a target has been contacted.

Furthermore, submarines can be located by means of the earth's magnetic field, since the mass of steel constituting a submarine hull warps or distorts the magnetic lines in the vicinity of the submarine. Thus, submarines can be located by measuring the magnetic field by means of the magnetic airborne detection equipment (MAD) used aboard fixed wing aircraft.

The underwater battery fire control system (UBFC, also referred to as UFCS) converts the information received from the sonar equipment into the data required for antisubmarine weapon and/or launcher operation.

The types of weapons used in antisubmarine warfare vary more than those used in any other fields of naval warfare. A list of the various ASW weapons with brief explanations is given in the following test, and the most conventional ASW weapons, except mines, are shown in the illustration below and the illustration on the following page.



152. TYPICAL ASW WEAPONS

1. Depth charges - Dropped from racks or projected. These charges may be actuated either hydrostatically (by water pressure) or acoustically

2. Projector charge (H/H) - Fired forward or abeam in patterns from either a stationary or a trainable launcher. The charges detonate only on contact.

3. Weapon "A" (or Alpha) - Rocket propelled from launcher Mk 108. This 12.75" charge is acoustically detonated.

4. Homing torpedoes - Fired from surface ships. Homing torpedoes search for and home on underwater targets. (There are several types of these torpedoes.)

5. Antisubmarine mines - Laid in fields, used against submarines.

6. Submarine rockets (SUBROC) - Fired from submarines and used primarily against other submarines. (The SUBROC is a rocket type missile with a depth charge warhead.)

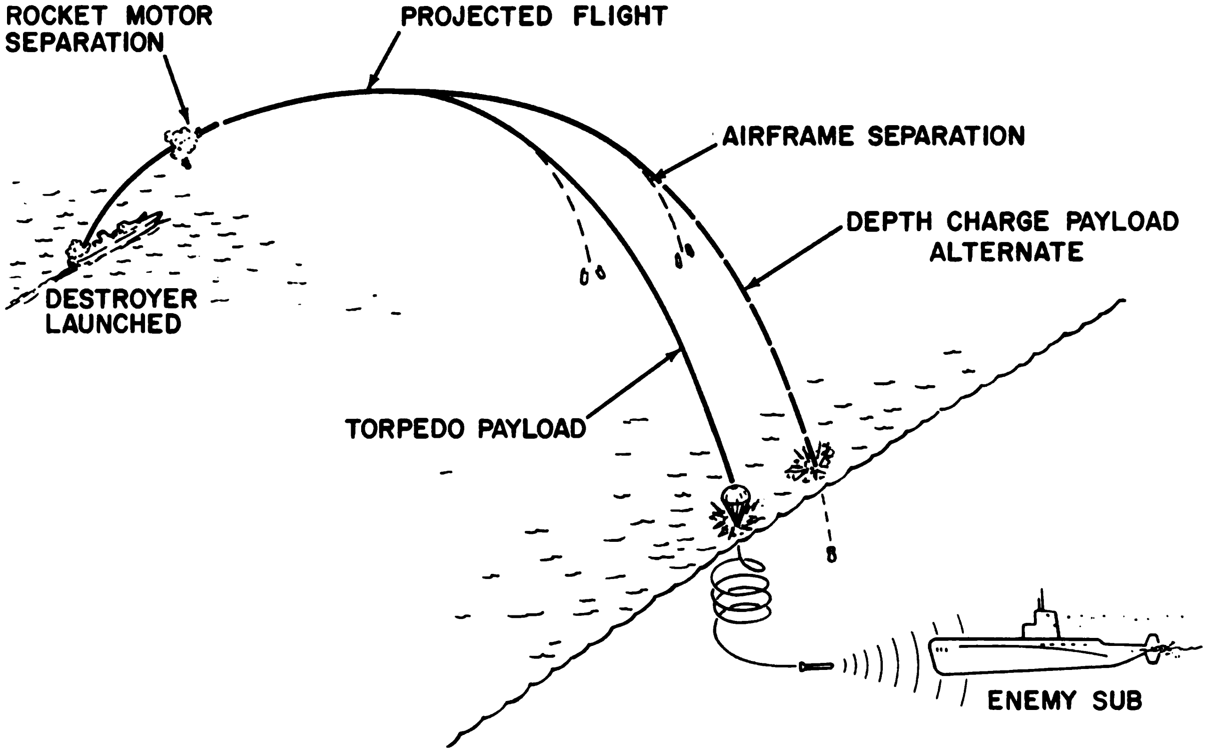
7. Antisubmarine torpedoes (ASTOR) - Fired from submarines, used against other submarines.

8. Antisubmarine rockets (ASROC) - Fired from shipboard, used against submarines. This rocket type missile payload can be either a depth charge or a torpedo.

The ASROC is a shipboard launched, solid fuel, rocket propelled, antisubmarine, supersonic ballistic missile. It has two configurations: One is a depth charge payload and the other is a torpedo payload. Both configurations are used against submarines operating below the surface of the sea.

The torpedo is provided with acoustic homing and is electromechanically controlled and propelled. The torpedo is divided into the following four sections:

1. Nose.
2. Warhead.
3. Control and battery.
4. Afterbody.



153. ASROC WEAPON SYSTEM (ANTISUBMARINE ROCKET)

The nose section contains a small sonar transducer that sends out the sound waves and receives the echoes necessary for homing.

The warhead, located just aft of the nose section, contains a 75-lb. charge of HBX-3. A contact type exploder (Mk 19 Mod 12) is used to detonate the warhead.

The torpedo control and battery section, located aft of the warhead, contains the electrical controls and the battery which supplies the power for torpedo operation. The battery is activated by sea water.

The afterbody contains the propellers, propeller shafts, motor, gear box, steering control, alternator, afterbody sheel, shroud ring, and vertical and horizontal stabilizers.

The overall length of the torpedo is 180"; it weighs approximately 940 lbs. and has a diameter of 13.25".

The depth charge is housed in a watertight pressure hull. Basically, the depth charge is divided into the following sections:

1. Nose.
2. Warhead.
3. Fuze.
4. Fuze to warhead adapter.
5. Tailcone.

The ASROC missile has two configurations: it can be either a torpedo or a depth charge.

The torpedo range is controlled by motor separation time which is set in before the missile is fired. Also set into the torpedo before missile firing is initial search depth and floor depth which indicate to the torpedo where to start searching and where to stop searching. The missile is also checked out before firing by certain voltages that are fed into the missile by relay transmitter Mk 43. (Rocket motor separation, torpedo payload, depth charge payload flight path, and airframe separation are shown in illustration on facing page.

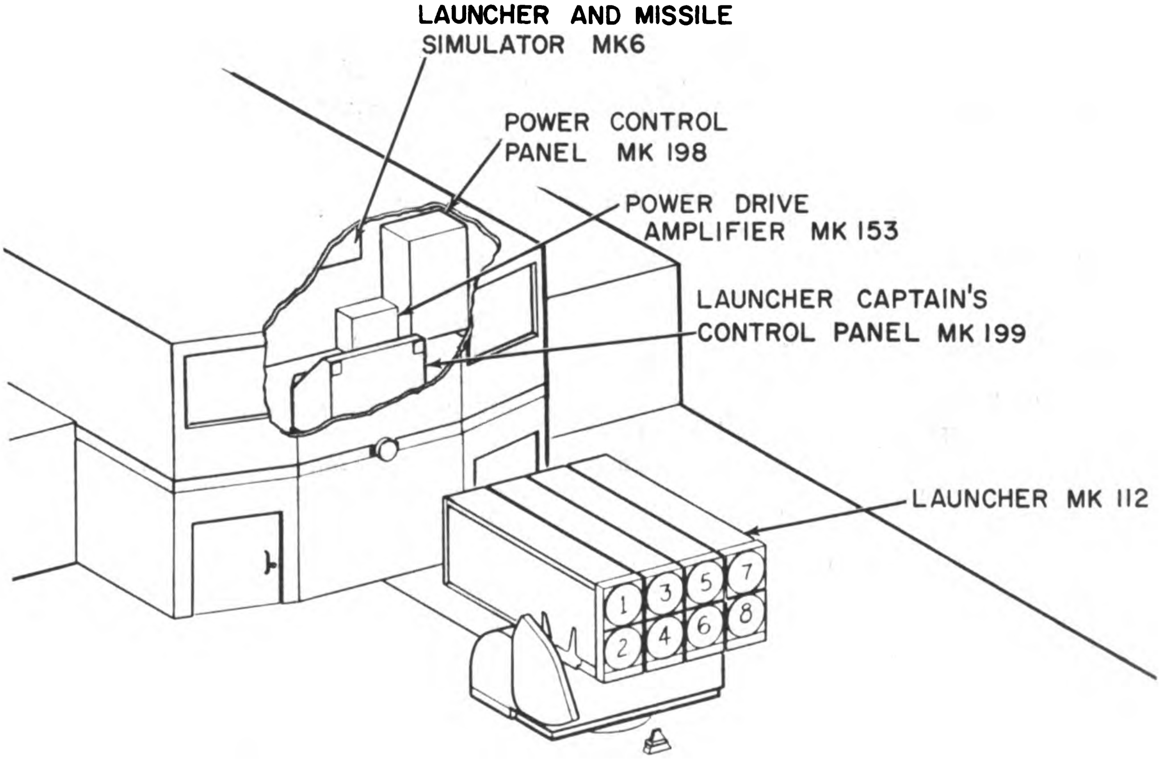
Like the torpedo, the depth charge missile is controlled in range by motor separation during flight. The depth charge does not have a set in depth; it detonates at a preset time after water entry.

Launching group Mk 16 (shown in illustration on page 244) contains the necessary equipment and provides facilities for the stowing, training, elevation, and launching of eight ASROC missiles. The launching group consists of the following components:

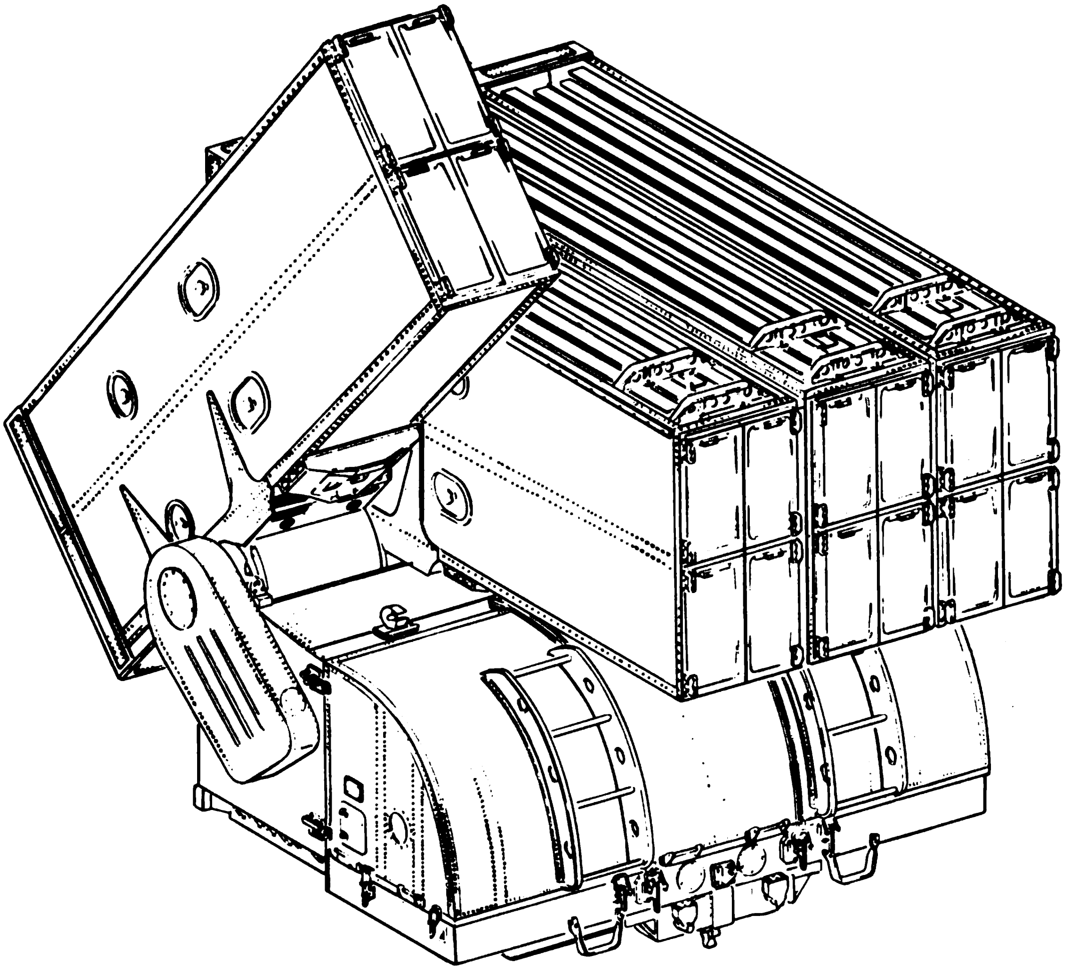
1. Launcher Mk 112.
2. Power control panel Mk 198.
3. Launcher captain's control panel Mk 199.
4. ASROC Loader crane.

The launcher shown in illustration on page 245 is located topside and includes all trainable components of the launching group. Four fully enclosed guides, which contain two missile cells each, are mounted on a torque tube that spans the width of the launcher carriage. The guides are mounted independently, and only one guide can be elevated at a time.

Each missile cell is equipped with a launching rail which is extended before firing, to guide the missile out of the cell and into its flight path. The forward end of each missile cell is enclosed by a door which is opened by the launching rail when the rail is extended. The aft end of each cell is enclosed by a flexible cover. When the missile is fired, this cover is ruptured by the blast


LAUNCHER AND MISSILE SIMULATOR MK6
POWER CONTROL PANEL MK 198
POWER DRIVE AMPLIFIER MK 153
LAUNCHER CAPTAIN'S CONTROL PANEL MK 199
LAUNCHER MK 112
1
2
3
4
5
6
7
8

154. LAUNCHING GROUP MK 16, TYPICAL EQUIPMENT ARRANGEMENT



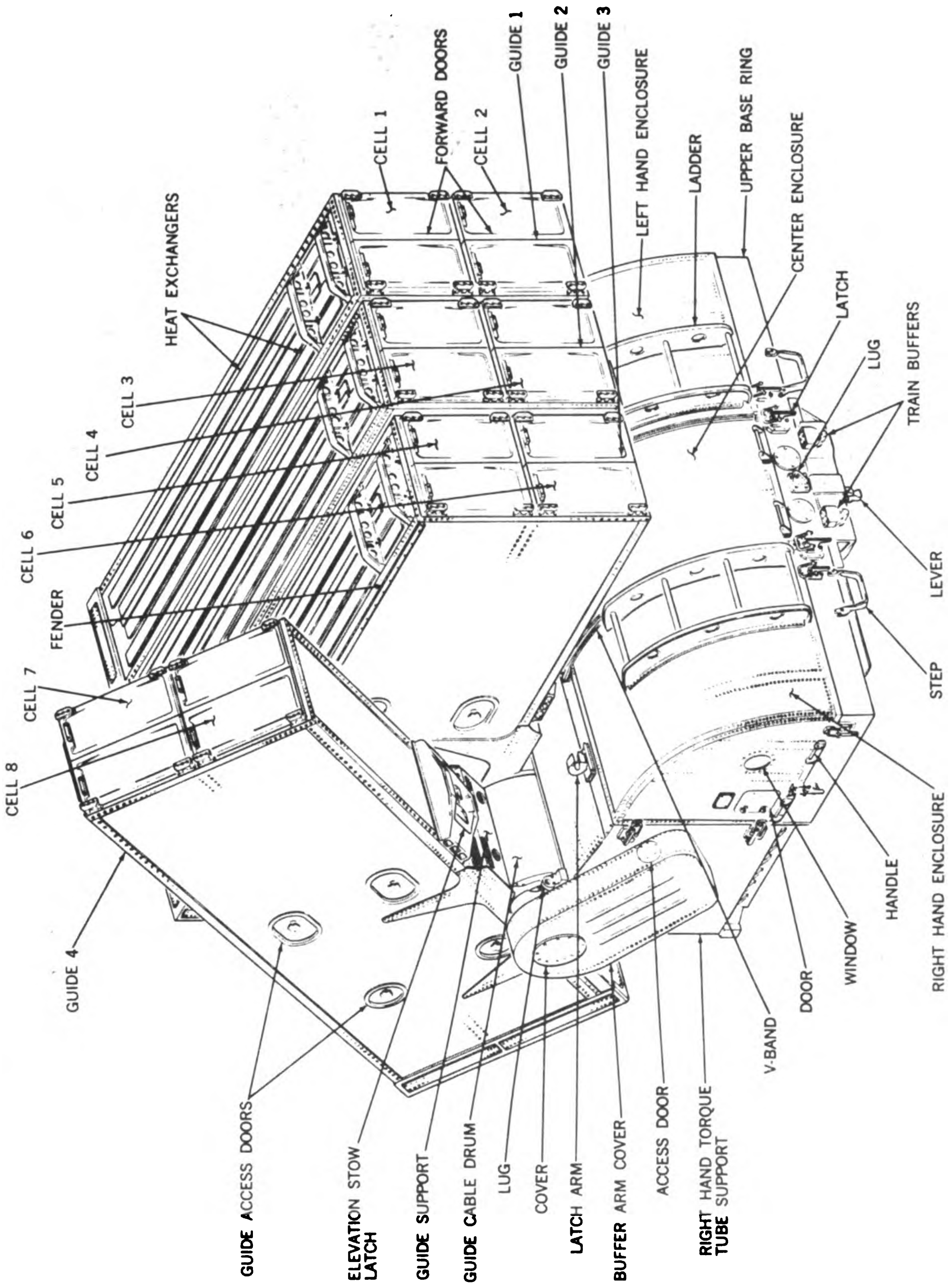
155. ASROC LAUNCHER

and must therefore be replaced after each firing.

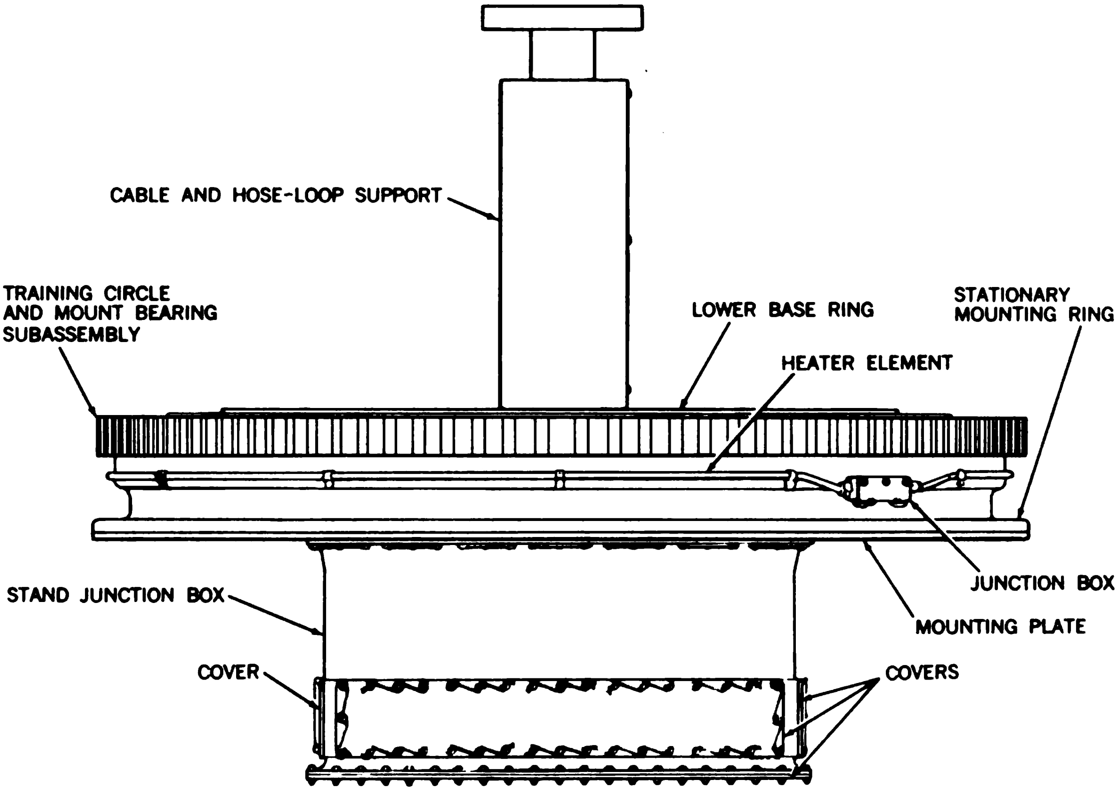
The launcher may be operated either in a remote or in a local mode of control. When operating in remote, the launcher is controlled by the UBFC; when operating in local, the launcher is controlled from the launcher captain's control panel.

Electrohydraulic power drives are used to train the launcher and to elevate the guides. The elevation power drive is geared to the torque tube. Since only one guide at a time can be engaged by the torque tube, only one guide at a time can be elevated.

The stand Mk 107 Mod 1 is secured to the ship deck and supports the launcher.



156. LAUNCHER MK 112



157. LAUNCHER STAND MK 107

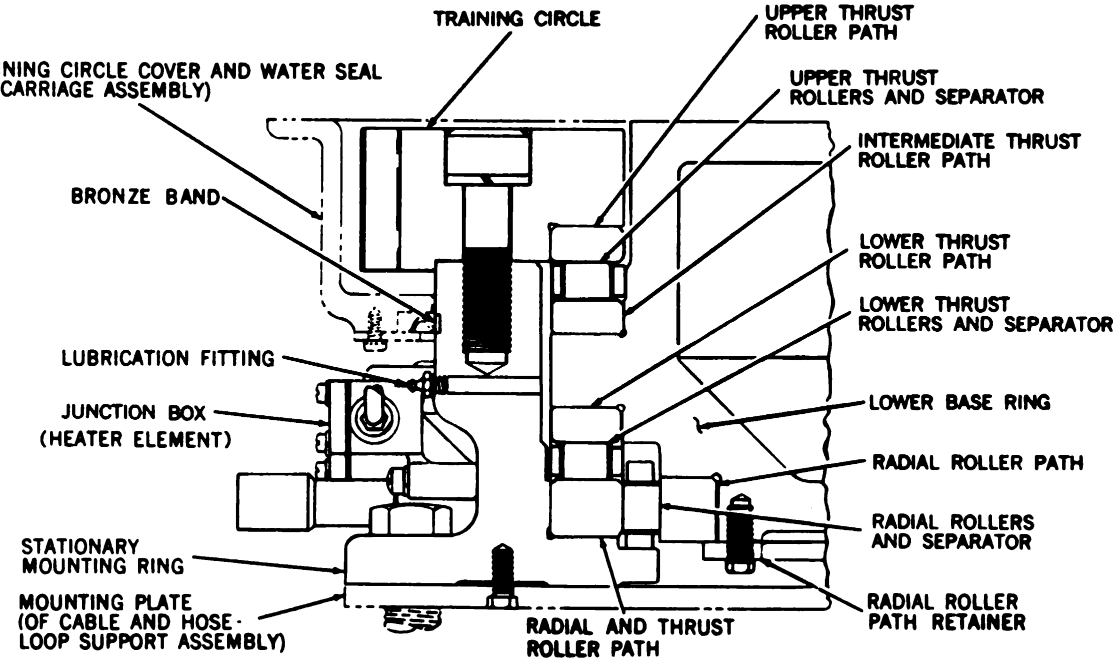
The major components of the stand are shown in the illustrations above and on the facing page and are listed below:

1. Training circle.
2. Lower base ring.
3. Roller bearing and roller paths.
4. Stationary mounting ring.
5. Heater elements.
6. Cable and hose loop supports.
7. Stand junction box.

The training circle, as shown in the illustration above, is a fixed ring gear that meshes with the train power drive pinion. The pinion, when rotated by the power drive, walks around the training circle, causing the launcher to train. The training circle is bolted to the stationary mounting ring. The inner lower surface of the training circle holds the lower base ring in the stand.

The lower base ring as shown in the illustration below, is bolted to the carriage and is supported in the stand by three sets of roller bearings. The rollers and their paths are made of hardened chromium plated and polished steel. For lubrication of the roller bearings, lubrication fittings are provided in the stationary mounting ring.

The stationary mounting ring is bolted to the ship deck through holes drilled in the outer flange of the mounting ring. The inner flange of the mounting ring provides a seat for the lower roller bearings and thus supports the weight of the launcher. (A cross sectional view of the stand is shown in the illustration below.)


TRAINING CIRCLE
UPPER THRUST ROLLER PATH
TRAINING CIRCLE COVER AND WATER SEAL (OF CARRIAGE ASSEMBLY)
UPPER THRUST ROLLERS AND SEPARATOR
INTERMEDIATE THRUST ROLLER PATH
BRONZE BAND
LOWER THRUST ROLLER PATH
LOWER THRUST ROLLERS AND SEPARATOR
LUBRICATION FITTING
JUNCTION BOX (HEATER ELEMENT)
LOWER BASE RING
RADIAL ROLLER PATH
RADIAL ROLLERS AND SEPARATOR
STATIONARY MOUNTING RING
MOUNTING PLATE (OF CABLE AND HOSE-LOOP SUPPORT ASSEMBLY)
RADIAL AND THRUST ROLLER PATH
RADIAL ROLLER PATH RETAINER

158. LAUNCHER STAND, CROSS SECTIONAL VIEW

The carriage Mk 7 includes all trainable parts of the launcher, except the guides and lower base ring. The carriage, shown in illustration on facing page, includes the following major components:

1. Carriage structure.
2. Torque tube.
3. Sector gear assembly.
4. Elevation depression buffers and buffer arm.
5. Elevation stow latch and guide drive pin arrangement.
6. Missile selector relay rack.
7. Rail selector relay rack.
8. Train buffers.
9. Train centering pin (not shown).
10. Firing interrupter.
11. Elevation power drive.
12. Elevation gear drive.
13. Train power drive.
14. Train gear drive.

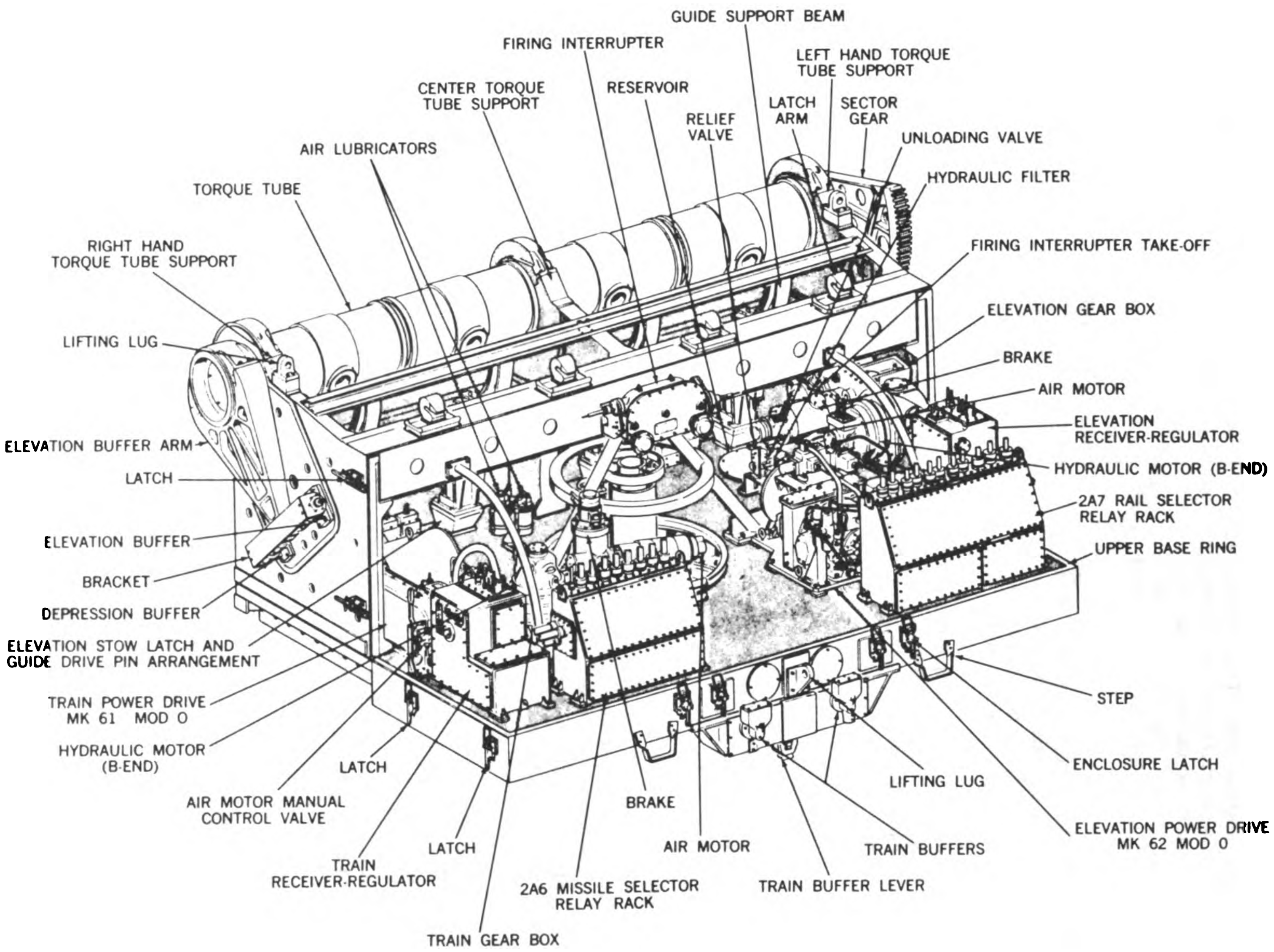
The carriage structure includes the upper base ring, torque tube supports, and guide support beams. The upper base ring is bolted to the lower base ring in the stand and supports the power drives, train gear drive, torque tube supports, and many other small assemblies.

The torque tube is mounted in the torque tube support bearings and acts as primary support for the four guides. A buffer arm is installed at one end of the torque tube; and elevation sector gear is installed at the other end. Four holes are machined into the torque tube, to receive the guide drive pins.

A sector gear, installed on the left end of the torque tube, transmits the elevation power drive output to the torque tube. Two switches are actuated by a cam on the sector gear. One switch is actuated to indicate when the torque tube is near 0° of elevation, and the other switch indicates when the torque tube is at 0° of elevation.

An elevation buffer, a depression buffer, and a buffer arm, located on the right end of the torque tube, stop the torque tube and guide at their limit of travel when the air motor is being used. The buffers also help to stop the guide and torque tube under power drive runaway conditions.

The elevation stow latch and guide drive pin are operated by a single cylinder and are interconnected by linkage. The stow latch arm holds the guide at the STOW position, while the guide drive pin connects the guide to the torque tube. Both units are mechanically arranged so that the stow latch arm is released after the guide drive pin is partially engaged by the torque tube.



159. CARRIAGE MK 7, ENCLOSURES REMOVED

When the guide elevates, the guide drive pin is kept engaged by the torque tube, by riding on a segment of circular track mounted to the carriage structure. This overlapping action of partial engagement and disengagement of the latch and pin insures positive control of the guide. (Operation of the latch and pin is shown in illustration on facing page.)

The hydraulic fluid to operate the elevation stow latch and guide drive pin is provided by an accumulator power supply. The elevation power drive electric motor drives the pump which supplies the hydraulic fluid for the accumulator. (A handpump is provided to charge the accumulator for maintenance or checkout purposes when the elevation power drive is not running.)

A missile selector relay rack and a rail selector relay rack are located on the forward part of the carriage. Each rack consists of relays and other electrical and electronic components required for launcher operation.

The train buffers serve to slow down and to stop the launcher at its extreme limits of right or left train. During normal power operation, the power drive is automatically stopped before the buffers start functioning; however, when the launcher is operated by means of the air motor or if the automatic limit stop and switch fail to function, the buffers would be actuated to stop the launcher in train. The assembly consists of two hydraulic buffers with a lever pivoted between the exposed ends of the pistons. The buffers and lever are mounted midpoint on the forward end of the upper base ring. The buffer lever protrudes downward and contacts a positive stop when the launcher reaches its right or left train limits.

When the buffer lever strikes the positive stop, buffing action is produced by hydraulic fluid being forced through tapered grooves in the piston housing. After the launcher leaves a positive stop, the buffer piston is returned by spring action to its extended position.

A train centering pin and its actuating mechanism are used to lock the carriage to prevent it from training. The carriage is locked by extending the centering pin into a hole in the training circle.

The firing interrupter, mounted on the guide support beam, opens the firing circuits when the line of fire reaches a predetermined distance from the ship's structure or equipment. The interrupter consists of two groups of electrical switches and their corresponding actuating mechanisms which are enclosed in a watertight case.

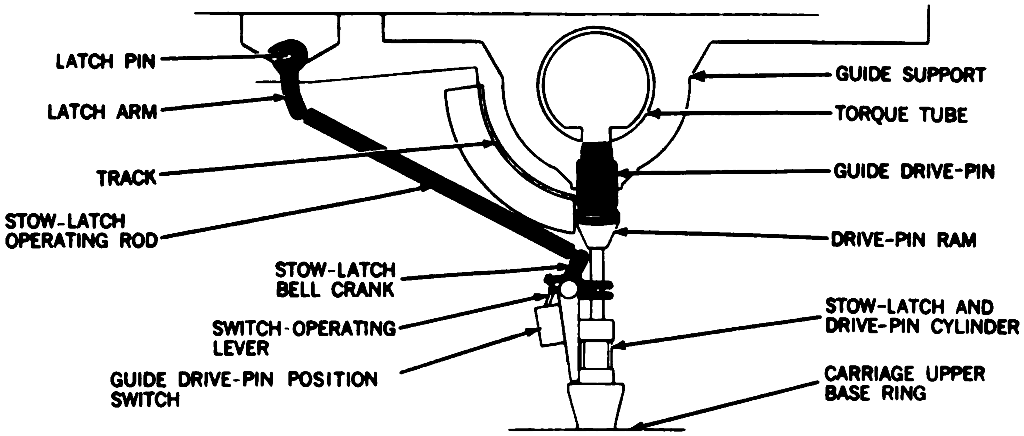
The train and elevation power drives and associated gear boxes provide the power required to train the launcher and elevate the guides. Both the train and elevation gear drives consist of the following major components:

1. Gear box.
2. Brake.
3. Air drive motor.

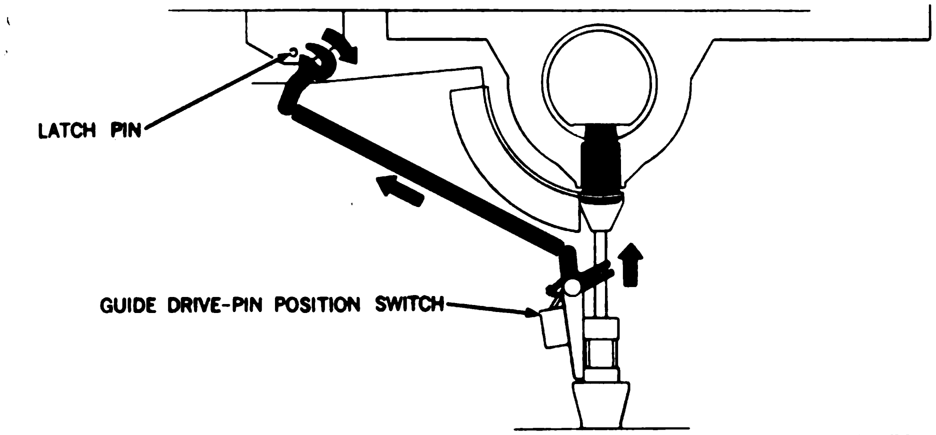
Both gear boxes reduce the speed of the B-end motor and thereby increase the output of the power drives. The gear boxes also provide outputs for the firing interrupter and receiver regulator and inputs for the brake and air drive motor.

The brakes, when set, hold the elevation and training components stationary when power is off and permit these components to be driven by the air drive motor. Basically, the brake assemblies consist of a series of alternating stationary and rotating disks which, when compressed by spring pressure, produce the braking effect. The brakes are released by hydraulic pressure.

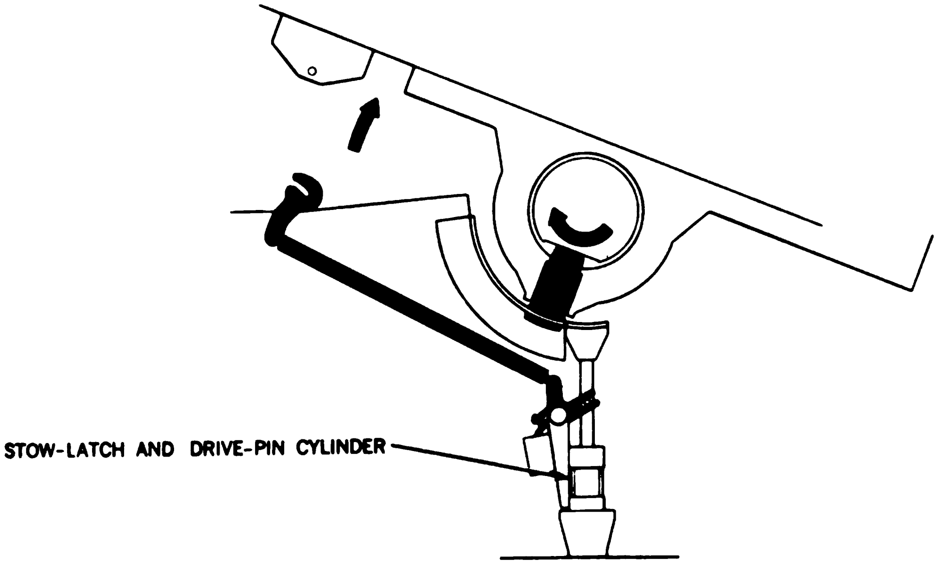
When the power is off, the air drive motors allow the launcher to be trained and elevated for maintenance purposes. The air drive motors use the ship's low pressure air supply. The motors can be operated in either direction and at variable speeds.



GUIDE AT STOW POSITON



GUIDE DRIVE-PIN EXTENDED AND STOW-LATCH RETRACTED



GUIDE BEING ELEVATED

160. ELEVATION STOW LATCH AND GUIDE DRIVE PIN ARRANGEMENT, OPERATIONAL SCHEMATIC

The launcher contains four guides. Each guide is arranged to stow and launch two ASROC missiles. Each missile is stowed in a cell. (Refer to illustration on facing page.)

The main components of a cell are as follows:

1. Aft closure.
2. Forward doors.
3. Launching rail.
4. Restraining latch.
5. Bottom and side snubbers.
6. Pneumatic system.

The aft closure, forward doors, and launching rail have already been described in the beginning of this topic.

The restraining latch functions as a firing detent during launching and serves as a positive lock against the fore and aft movements of the missile at all other times. The latch engages the restraining lug of the missile. A manual release mechanism is provided to retract the restraining latch during loading or unloading.

Two bottom and four side snubbers are used to prevent radial movement of a stowed missile. The snubbers are extended and retracted by air pressure.

The snubbers, launching rail, and restraining latch for each cell are operated by an electrical pneumatic system.

The power control panel Mk 198 (shown in illustration on page 254) is located in a control room behind the launcher. (Refer to illustration on page 254.)

The power control panel cabinet consists of two cast aluminum housings with doors and seals that form airtight enclosures for wiring and electrical components. The panel is shock mounted at its top and at its bottom.

The outer surfaces of the upper and lower cabinet doors form the panel face. Manually operated electrical components are mounted to the back of the panel face. The operating shafts of these components extend through the panel face.

The bases for the fuse holders and indicating lights are also mounted on the back of the panel. Each door (panel face) has a door-check mechanism which locks the door at any desired position. The doors are held closed by captive spring screws which remain in the door when the door is unlocked.

Indicator type fuses are provided for all lighting and major supply circuits. The power control panel has twenty-nine Navy type 12FHI fuses with provisions for storing fourteen spares.

Overload relays and circuit breakers are provided in all power circuits for the protection of the circuits and the equipment.

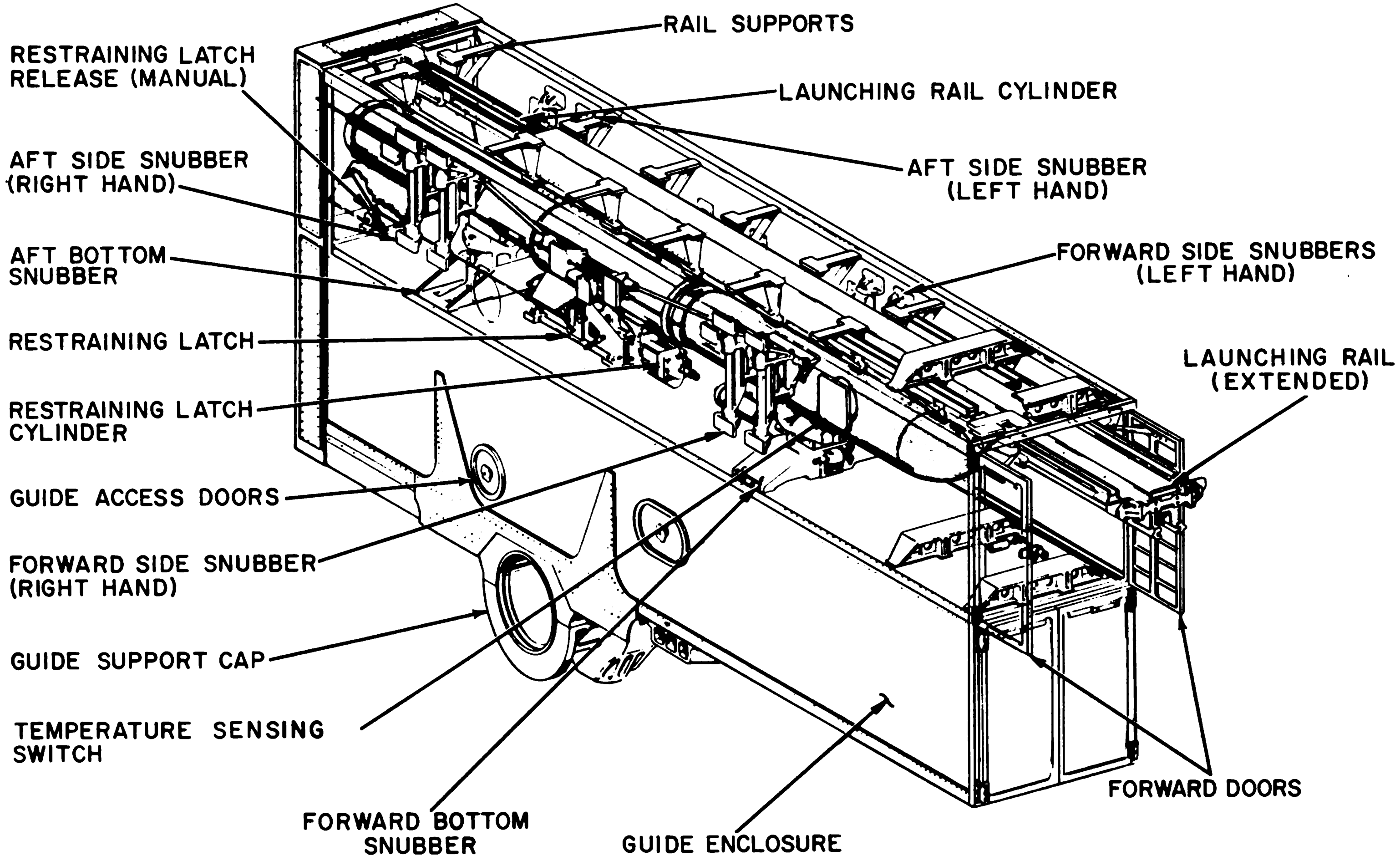
Power Control Panel Mk 198:

The power control panel Mk 198 contains equipment which performs the following functions:

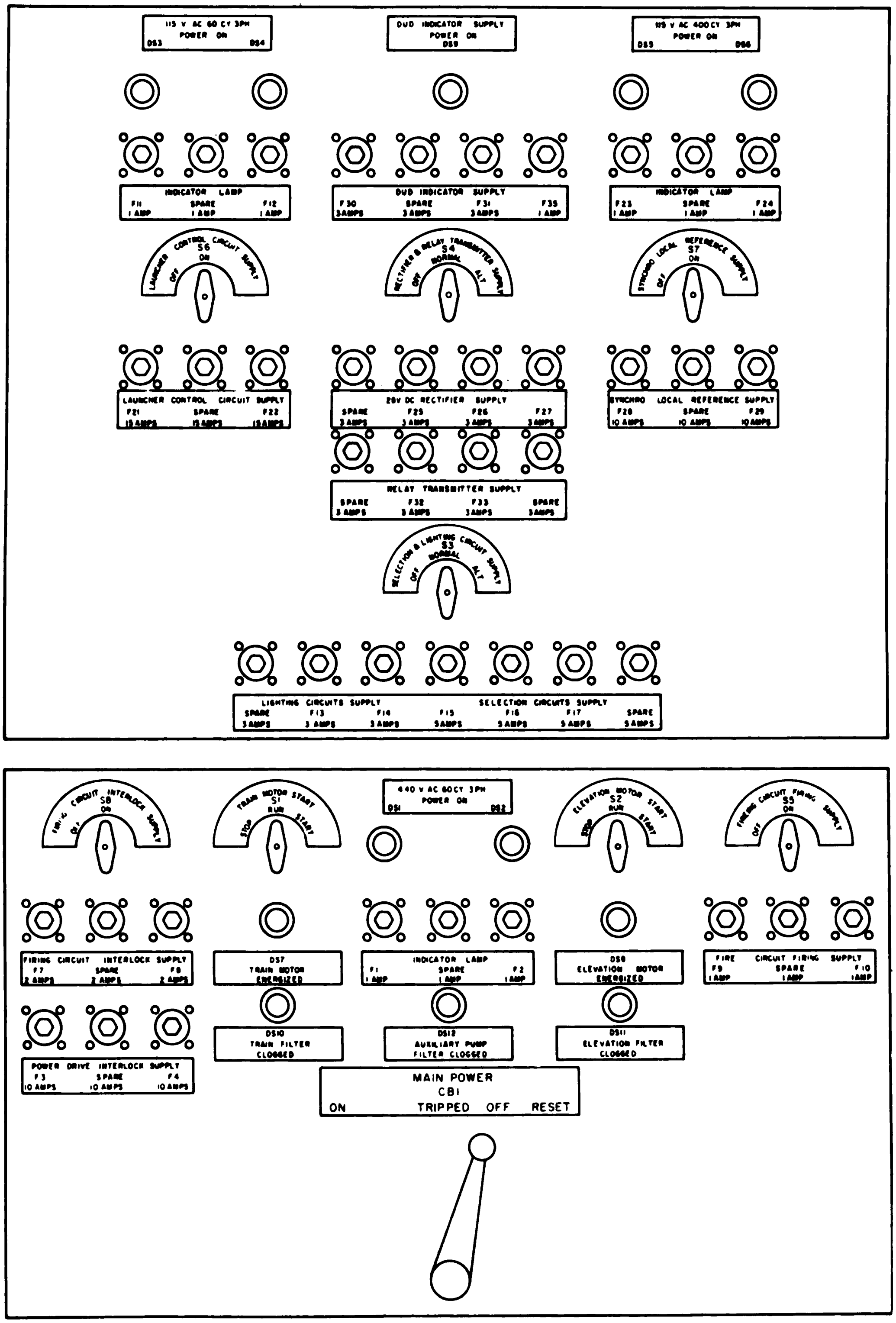
1. Connects and disconnects main power supply (440V, 60 cycle, 3 phase).
2. Prevents overloads in the 440V supply.
3. Connects the lighting and selection circuits to normal or alternate power sources.
4. Energizes the BUSHIPS rectifier circuits and relay transmitter circuits during switching from normal to alternate power sources.
5. Starts and stops the train and elevation power drive motors.
6. Energizes and deenergizes the local control supply, synchro local reference supply, and firing interlock supply circuits.

Launcher Captain's Control Panel Mk 199:

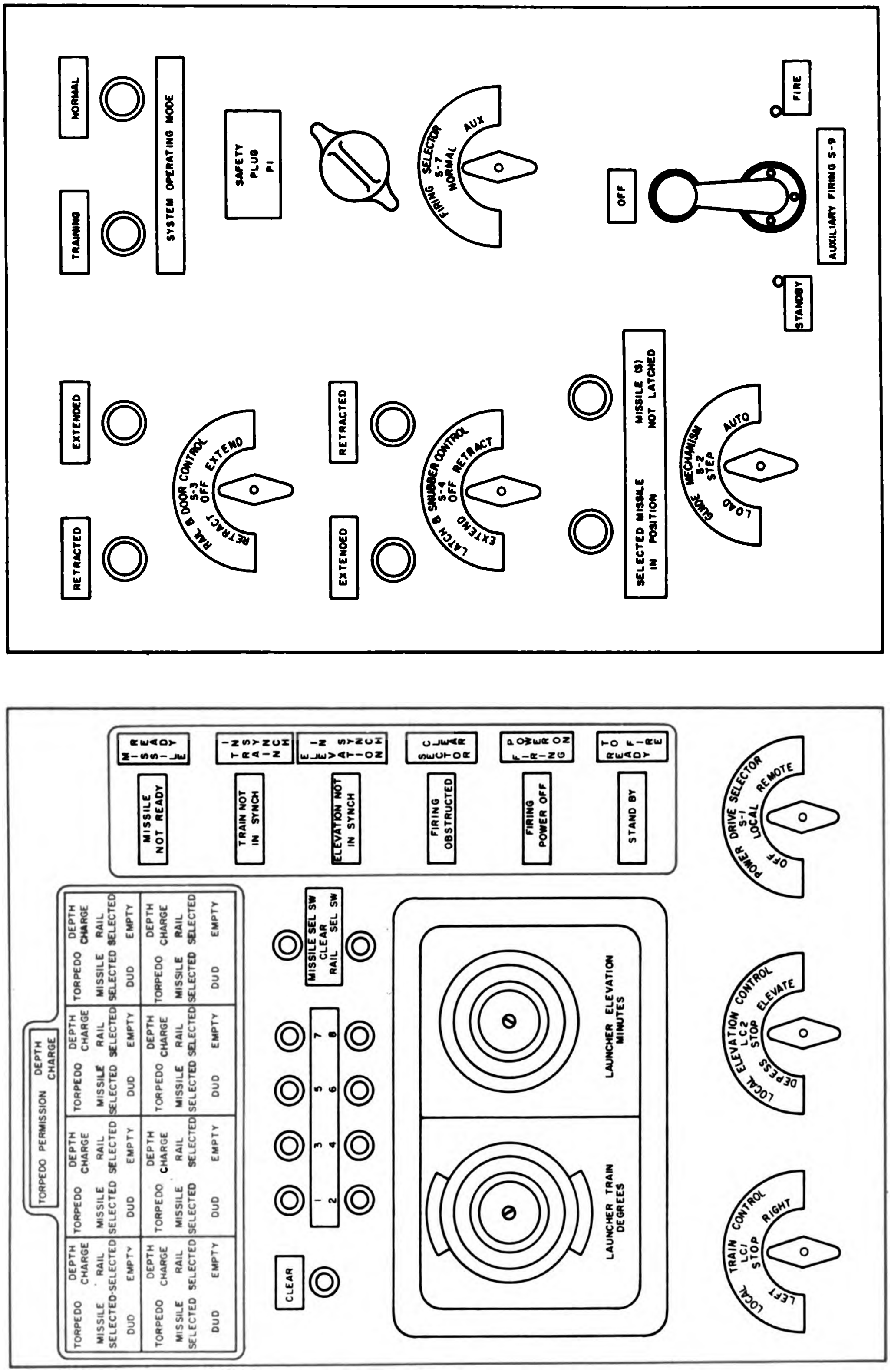
The launcher captain's control panel Mk 199, shown in illustration on page 255, consists of two (upper and lower) cast aluminum housings bolted together on the


RAIL SUPPORTS
RESTRAINING LATCH RELEASE (MANUAL)
LAUNCHING RAIL CYLINDER
AFT SIDE SNUBBER (RIGHT HAND)
AFT SIDE SNUBBER (LEFT HAND)
AFT BOTTOM SNUBBER
FORWARD SIDE SNUBBERS (LEFT HAND)
RESTRAINING LATCH
LAUNCHING RAIL (EXTENDED)
RESTRAINING LATCH CYLINDER
GUIDE ACCESS DOORS
FORWARD SIDE SNUBBER (RIGHT HAND)
GUIDE SUPPORT CAP
TEMPERATURE SENSING SWITCH
FORWARD DOORS
FORWARD BOTTOM SNUBBER
GUIDE ENCLOSURE

161. GUIDE MK 7, CUTAWAY VIEW



162. POWER CONTROL PANEL MK 198



163. LAUNCHER CAPTAIN'S CONTROL PANEL MK 199

inside. Each housing is equipped with doors and seals which form an airtight protective enclosure. The cabinet is supported at the back and bottom by shock mounts. The panel face is formed by hinged doors. (The sealing and mounting features of the switches, lights, and other components are the same as those of the power control panel.)

The launcher captain's control panel contains equipment for controlling the following operations:

1. Training and elevating the launcher in local control.
2. Extending and retracting the rails in step control.
3. Opening and closing the doors in step control.
4. Extending and retracting the latches and snubbers in step control.
5. Interrupting rail and missile selection firing circuit in local control.
6. Manual transfer of the firing circuit source.
7. Auxiliary firing.

ASROC Loader Crane:

The ASROC loader crane is used for loading ASROC missiles into the launcher guides. The loader picks up an ASROC missile from the missile container, mates it with the launcher rail of a cell, and rams the missile into the cell by means of an air driven motor.

The loader crane consists of the following five major components:

1. Electrohydraulic power unit.
2. Crane post.
3. Turning gear assembly.
4. Pivot head assembly.
5. Rammer rail assembly.

The electrohydraulic power unit furnishes the power to raise, lower, and train the loader crane.

The crane post is permanently mounted to the ship's deck, adjacent to the launcher, and consists essentially of a combination of upright, concentric cylinders and pipes. The crane post raises and lowers the loader crane in response to the application of electrohydraulic power. The concentric arrangement of the hydraulic elements permits crane rotation around the vertical axis of the crane post.

The turning gear assembly rotates the external cylinder of the crane post. This rotating force is applied by a hydraulic motor, governed in speed and direction by a control valve. Although normally rotation of 360° is possible, hydraulic limit stops are provided to prevent damage to ship's structure. A calibrated dial, located around the cylinder, indicates the positions of pivot head and rammer rail for launcher loader alinement.

The pivot head assembly is a triangularly shaped structure, attached at its apex to a cylindrical arm extending horizontally from the crane post. The base of this structure forms the trackway upon which the rammer rail support roller travels. The pivot head and rammer rail are rotated hydraulically around the extension of the arm, are driven by a hydraulic cylinder, and are controlled by positioning a bypass valve.

The rammer rail assembly supports, guides, and rams the ASROC missile into the launcher. This assembly is mounted to the roller trackway of the pivot head assembly. The travel motion of the rail on the trackway is controlled by a double acting hydraulic cylinder which is operated by a hydraulic handpump.

The rail is fitted with jaws which can be opened to engage the ASROC missile lugs and can be locked by a handlever. When the jaws are locked, the crane is raised to lift the missile from its container.

One end of the rammer rail is fitted with interlocking latches that secure the rammer rail to launching rail. At the other end of the rammer rail is an air driven motor which drives a sprocket engaged with a roller chain. This motor and chain drive ram the missile into the launcher cell until the missile is 12 inches from its final position. At this point, the air supply to the motor is automatically cut off, and the ramming sequence is completed manually by operation of a handcrank attached to the air motor shaft.

When the loader crane is not used, the rammer rail is detached and stowed in a specially fitted rammer rail stowage. The loader is operated by 100 psi air pressure from the ship's supply and by hydraulic pressure at a maximum of 850 psi.

The ASROC loader crane controls are briefly explained in the following text:

1. Master hydraulic drive control - controls raising, lowering, and rotation of the loader crane.

2. Hydraulic drive selector - selects rotary or hoist operation for master hydraulic drive control.

3. Bypass interlock operating lever - opens and closes hydraulic bypass, to free or lock pivot head when it is rotated for alinement of rammer rail; also locks launcher rail mating latch.

4. Rammer rail operating lever - controls fore and aft movements of rammer rail on trackway.

5. Rammer rail operating bypass lever - selects direction of rail movements on trackway.

6. Lug capturing operating lever - opens and closes lug capturing jaws, to hook on missile for lifting and ramming.

7. Air drive motor control - controls air driven rammer motor, to move rammer fore and aft.

8. Rammer handcrank - manually moves rammer fore and aft.

9. Rammer latch release chain - disengages rammer latch from thrust neutralizer of missile.

10. Foot operated bypass valve - provides slow, positive control during loading operation when missile is being engaged by loader rail.

QUIZ SHEETS:

1. Sound waves travel slower under water than through the air.

   True________or False___________.

2. The equipment which detects submarines by measuring the magnetic lines of force is called

   a. Sonobuoy.
   b. Hydrophone.
   c. MAD.
   d. UBFC.

3. List the three main units of the ASROC weapon system.

   a.____________________________.
   b.____________________________.
   c.____________________________.

4. The range of the ASROC missile is controlled by one of the following:

   a. Rail.
   b. Set in depth.
   c. Motor separation.
   d. Gun fire control system.

5. The Mk 112 launcher permits independent train and elevation of each guide.

   True________or False___________.

6. List the five main units of the launching group Mk 16:

   a.____________________________.
   b.____________________________.
   c.____________________________.
   d.____________________________.
   e.____________________________.

7. The launching guide (cell) forward door is cammed open by the action of one of the following guide components:

   a. Launching rail.
   b. Restraining latch.
   c. Aft closure.
   d. Bottom forward snubber.

8. All four guides can be elevated and trained at the same time.

   True________or False___________.

9. The train power drive pinion meshes with one of the following stand components:

   a. Lower base ring.
   b. Stationary mounting ring.
   c. Training circle.
   d. Roller paths.

10. The primary support for the four guides is provided by one of the following:

    a. Torque tube.
    b. Sector gear assembly.
    c. Elevation gear drive.
    d. Upper base ring.

11. The elevation and depression buffers are both located on one end of the torque tube.

    True________or False___________.

12. Fuses of lighting circuits and of the major electrical supply circuits are located in one of the following units:

    a. Panel Mk 198.
    b. Panel Mk 199.
    c. Amplifier Mk 153.
    d. Simulator Mk 6.

13. The launcher can be trained and elevated in local control from power control panel Mk 198.

    True________or False___________.

14. List the five major components of the ASROC loader crane.

    a.____________________________.
    b.____________________________.
    c.____________________________.
    d.____________________________.
    e.____________________________.

15. Train and elevation power drives are similar in design and are interchangeable.

    True__________or False_______________.

Accuracy of notes checked by instructor:

Date____________________________________

Trainee's initials__________________________

Section 10

INTRODUCTION TO FIRE CONTROL AND AUTOMATIC WEAPON CONTROL EQUIPMENT

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Fire Control Fundamentals	262
2.	Fire Control System	270
3.	Introduction to Fire Control Equipment	278
4.	Electric Hydraulic Power Drives and Their Operation	280
5.	Amplidyne Followup System Components and Operation	284
6.	Battery Alinement	288

TOPIC 1: FIRE CONTROL FUNDAMENTALS

You Are Now Going to Learn:

1. Importance of fire control.
2. Methods of firing.
3. Types of fire.
4. Factors to be considered in the fire control problem.

Discussion Points for this Topic Are:

1. Introduction to fire control.
2. Importance of fire control.
3. Fire control terms.
4. Methods of firing.
5. Types of fire.
6. Factors to be considered in the fire control problem:
    a. Target motion.
    b. Own ship motion.
    c. Force of gravity.
    d. Air resistance.
    e. Wind.
    f. Drift.
    g. Rotation and curvature of earth.
    h. Initial velocity of projectile.
    i. Parallax.
7. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Optional reading list:
    a. NAVPERS 10173A, FT3.
    b. NAVPERS 10185, GMG 3 and 2. Chapters 8 and 9.

INFORMATION AND DISCUSSION:

In this topic guns, mounts, and projectiles will be discussed; the same information also applies to a certain extent to launchers and missiles.

Our Navy is only as strong as our ships are, and a ship is only as strong as its fire power. To be effective, fire power must be accurately controlled. To score a hit, the wild game hunter has only to consider the lead for a moving target; fire control of modern weapons, however, it much more complicated. This control can be accomplished with the aid of precision instruments for sighting the target, for obtaining the proper range and bearing, and for laying the gun.

Modern guns can shoot with deadly accuracy at ranges of up to 20 miles. Some of our missile systems, however, have effective ranges in excess of 100 miles. Since these guns and missile systems are mounted onboard ship, the problem of fire control becomes more complicated due to the ship movement, which sometimes resembles the motion of a cork being carried by a rough stream. Also, the target is usually maneuvering, that is, taking evasive action to escape a hit. With all these facts in mind, it can be understood why fire control is called the science of laying the gun so that the projectile hits the target.

Considering the range at which targets are acquired and the speed at which they travel, one can readily see the need for highly accurate precision instruments. A gunner's mate must have his equipment in tip-top condition; however, if he has no means of accurately directing the gun so that the projectile contacts and destroys the target, the gun does not serve the purpose for which it is intended.

To better understand all the aspects of fire control, a person must become familiar with certain terms and their definitions. These terms will be helpful in understanding the language of fire controlmen and will also facilitate understanding of weapon system operations. Some of the most common terms used in fire control are listed below. (For other fire control terms, refer to GLOSSARY in Section 2, Topic 1, and to OP 1700.)

Laying the gun - Aiming the gun in such a way that the projectile hits the target.

Deck plane - Plane parallel to the ship deck.

Horizontal plane - Plane tangent to the earth's surface or parallel to such a plane.

Vertical plane - Plane perpendicular (at right angle) to horizontal plane.

LOS (line of sight) - Line from director to target or from gunsight to target.

LOF (line of fire) or LOD (line of departure) - Line in which projectile is traveling at the instant it leaves the gun.

Range - Straight line distance (in yards) from gun to target.

True target bearing - Angular value measured clockwise from north to line of sight.

Relative target bearing - Bearing of target measured clockwise from bow of own ship to line of sight.

Target elevation - Angle between horizontal plane and line of sight measured in vertical plane.

Trajectory - Curve of projectile from gun to first point of impact.

Roll - Angle between norizontal plane and deck plane measured in the vertical plane through a line perpendicular to own ship centerline.

Pitch - Angle between horizontal plane and deck plane measured in vertical plane through own ship centerline.

The method of sending a firing signal (impulse) to a gun is called the firing method. Two firing methods are used:

1. Pointer firing.
2. Master key firing.

The pointer at the gun can accomplish pointer firing in two ways, either by closing a key which sends an electrical current into the gun firing circuit (electrical firing) or by stepping on a pedal which operates a firing pin in the gun (percussion firing).

Master key firing is performed from a remote control station either by someone operating a key or automatically whenever the ship reaches a predetermined angle as it rolls or pitches with respect to the LOS.

Unlike guns, missiles must usually be fired by master key from a remote station (usually Weapons Control), except in emergency tactical situations.

The ways in which firing of a gun or several guns is accomplished are defined as types of fire. Some of the common types of fire are defined as follows:

Salvo fire - Simultaneous firing of two or more guns at the same target. Salvos may be fired by entire batteries or by individual mounts.

Split salvo fire - Firing in which not all guns of a mount participate. Three 2-gun mounts may participate in a split salvo, provided that only one gun of each mount fires.

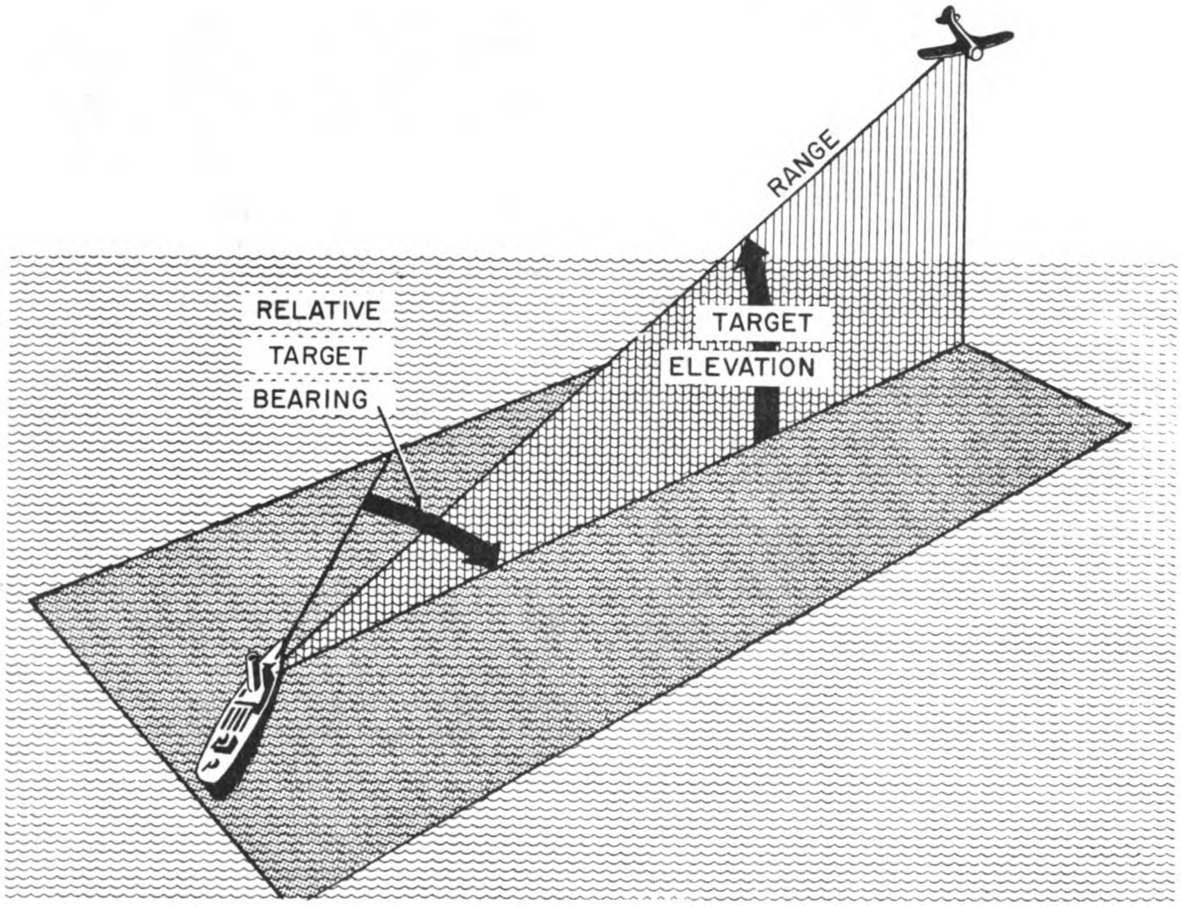
Partial salvo fire - Simultaneous firing of all guns in a mount, but not all mounts in the battery.

Continuous fire - Individual firing of each gun when ready.

Slow fire - Delayed firing, to allow application of spots or corrections to conserve (save) ammunition.

Rapid fire - Firing that is not delayed for application of spots or corrections or to conserve ammunition.

If a moving surface target is 15 miles away, a 16-inch projectile takes almost a minute from the time it leaves the muzzle of the gun until it gets to the target. If the target is making 40 knots an hour, it will have moved approximately 1,300 yards by the time the projectile has traveled 15 miles.



164. RELATIVE TARGET BEARING, ELEVATION ANGLE, AND RANGE FOR AIR TARGET

The result would be a sure miss unless the gun is laid to lead the target by the correct angle.

If an air target is moving left or right, the gun train angle will have to be corrected; if the target is moving away from or toward the ship, the gun elevation angle will have to be corrected. (Relative target bearing, elevation angle, and range are shown on illustration above.)

The firing problem is still more complicated due to the fact that own ship does not just swing around the hook, but also moves: It rolls and pitches because it is affected by ocean ground swells and waves. Therefore, the gun angles have to be automatically corrected to compensate for own ship motion, roll, and pitch.

There are also other things to be considered. As the projectile speeds toward the target, the force of gravity pulls it down, the spin of the projectile pushes it sideways like a curving baseball, the wind shoves it one way or the other, and air resistance slows it down. Therefore, still more corrections to gun train and elevation are necessary.

Each type of gun is tested at the Naval Proving Grounds where a study of the effects of gravity, spin, wind, and air resistance is made for various gun elevation angles and ranges. The necessary corrections are then calculated and entered on range tables.

Modern computers are built to solve the problem of where to lay the gun, constantly allowing for instantaneous changes in motion of own ship and target.

When a target has been located, the following three values must be determined:

1. Range.
2. Relative target bearing.
3. Elevation angle.

Own ship motion can easily be determined by means of the ship gyrocompass which shows own ship course and by means of the pitometer log which indicates own ship speed. When these values are known, the computer can determine the speed and course of the target relative to own ship and LOS.

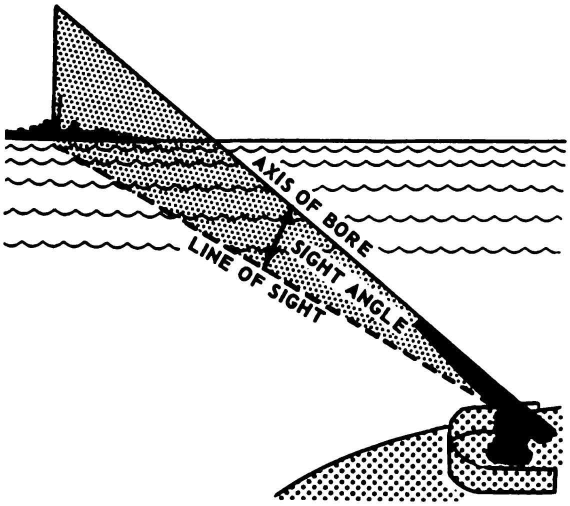
Another important factor is roll and pitch of own ship. The ship rolls from side to side and pitches fore and aft. These movements tilt the trunnions (pivots on which the gun moves in elevation) out of level, thus causing an error in train and elevation. Since the gun is rarely trained to a 0° bearing, roll and pitch must be considered in relation to LOS. Roll and pitch are constantly being measured, and the results are supplied to the computer.

The fire control problem is not an easy one, for however fast the projectile moves, it still takes time to reach its destination. During that time, the projectile is affected by several disturbing factors; however, through the science of exterior ballistics (study of projectiles in flight) it has been determined what these disturbing influences are and how to compensate for them.

The four disturbing factors are:

1. Force of gravity.
2. Air resistance.
3. Wind.
4. Drift.

Force of gravity is the first and most important factor affecting a projectile's course, since the force of gravity effects the trajectory curve. In interstellar space, there is little or no gravitational force; therefore, if a projectile would be fired in intersellar space, its trajectory would be a straight line. In the earth's atmosphere, however, the force of gravity is constantly pulling the projectile down, regardless of its velocity.



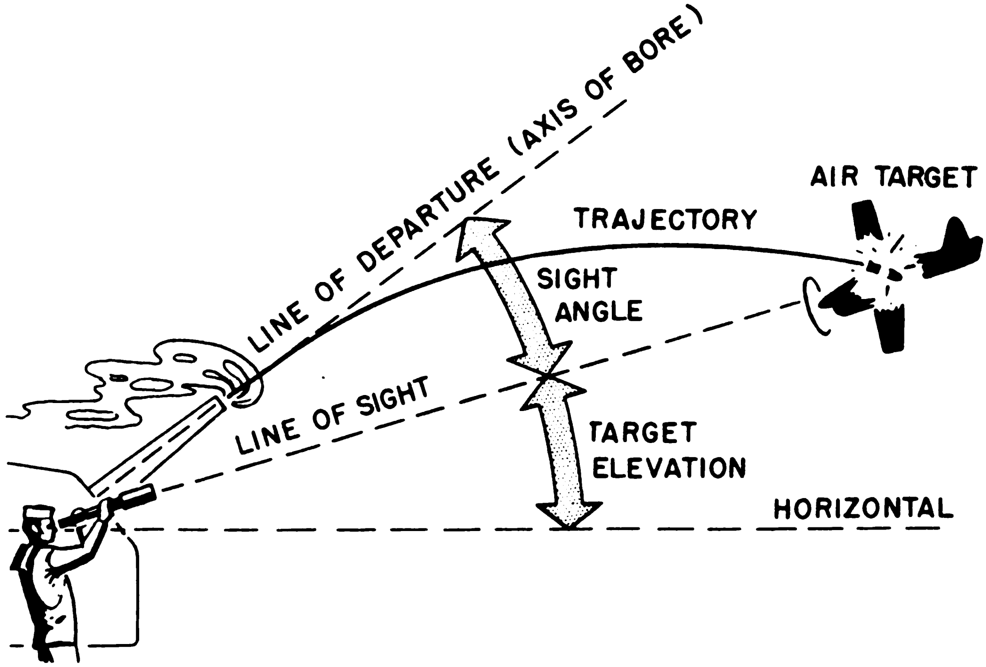
165. SIGHT ANGLE

A projectile in flight is always falling; even firing from a gun can not keep a projectile from falling. If a projectile were fired at 0° elevation, that is, with the gun in perfect horizontal position, and at the same time another projectile of the same type were dropped over the side of the ship from exactly the same height as the gun, both projectiles would fall into the sea at the same instant. Of course, the projectile fired from the gun would be some distance away when it hits the water, but it would fall just as fast as the one which was dropped overboard.

To keep the projectile in flight until it reaches the target, the gun is elevated, that is, tilted at an angle so that it is directed toward a point above the target. If the tilt angle is correct, the trajectory will pass through the target. However, the distance a projectile can travel in this way is limited.

If the effects of air resistance would not exist, the range of the projectile would increase with the angle of elevation up to 45°. If the elevation angle would be increased to exceed 45°, the height reached by the projectile would be increased, but its range would be decreased.

The angle by which the gun is elevated to attain the desired range is called the sight angle. The sight angle is defined as a vertical angle and is measured in degrees and minutes between LOS and LOD. (Refer to illustration shown above.)



166. SIGHT ANGLE AND TARGET ELEVATION ANGLE

The sight angle is not the same as the target elevation angle. While the sight angle is measured between LOS and LOD, the target elevation angle is measured between LOS and the horizontal plane. (Refer to illustration shown above.)

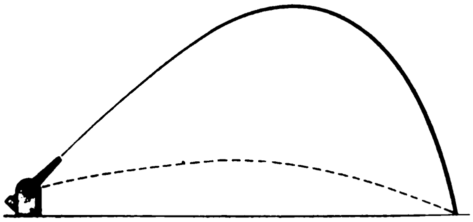
Since the pull of gravity within the heights reached by projectiles may be considered to be everywhere the same, the behavior of projectiles is fundamentally uniform, and the gun therefore may be elevated accordingly to acquire the desired range.

Air resistance is the second disturbing force which affects the flight path of a projectile. A projectile speeding along at nearly half a mile per second does not fly through the air - it seem to plow through it.

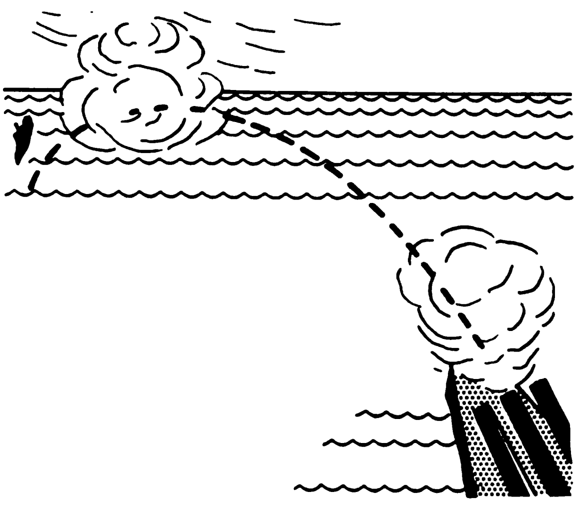
The air disturbance created by the projectile shows up its flight, thus keeping the projectile from going as far and as high as it would in a vacuum and also causing it to fall at a steeper angle.

Air resistance can be compensated for by increasing the range through additional gun elevation (increase of sight angle). (Refer to illustration shown below. The dotted line shows the trajectory of a projectile in a vacuum; the solid line shows the trajectory of a projectile in the aid. The gun is elevated to increase range of projectile.) Air density varies with altitude and barometric pressure. The amount of necessary compensation depends not only on range, but also on altitude of the projectile and weather conditions at time of firing.

Wind is the third disturbing force. Air density affects the flight of a projectile whether the air is moving or not. For the sake of simplicity, in this discussion it was



167. COMPENSATION FOR AIR RESISTANCE



168. EFFECT OF WIND ON PROJECTILE FLIGHT

assumed that the air does not move. However, it does move, and this movement is called wind.

Wind is not only air movement, but also movement with respect to something else. If this air movement is in respect to something stationary (the earth, for example), it is called true wind.

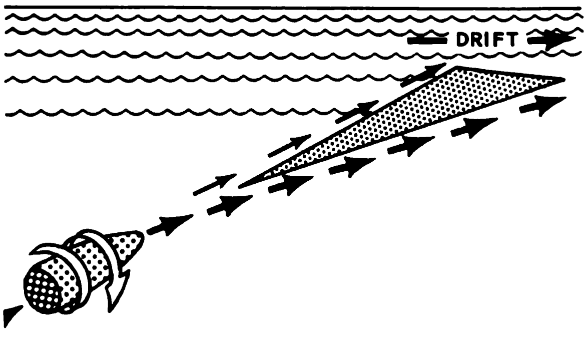
On a moving ship, even if a dead calm exists, there is air movement. In terms of gunnery, that movement is considered wind. If the ship is moving north and if the true wind is coming from the west, a north-west wind is felt. This wind, caused by air movement and ship movement, is called apparent wind.

The effect of wind on the flight of a projectile depends on the strength of wind that blows across the line of fire (crosswind) and on the strength of wind that blows along the line of fire (range wind). The range wind tends either to push the projectile forward or to blow against it and retard its flight. In a similar way, the crosswind pushes the projectile either to the right or to the left, thereby deflecting its path as shown above.

When absolute accuracy is desired, balloons are sent aloft and are observed, to measure the wind at various altitudes. When all measurements have been taken into account, they are averaged and the result is called ballistic wind. Compensation for the effect of ballistic wind is made in fire control calculations.

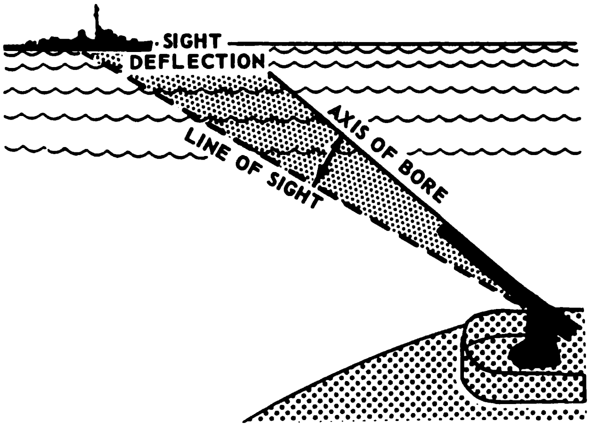
Drift, the fourth disturbing factor, is caused by the interaction of the clockwise spin of the projectile combined with the force of gravity and air resistance. The effect of drift is a deflection of the projectile's course to the right, as shown below. (Except for .45 caliber pistols, all guns in the U. S. Navy fire projectiles that drift to the right.) Drift increases with range and is independent of wind. Drift should not be confused with wind effects.

Because of drift, wind, own ship movement, target movement, and other disturbing factors, it is seldom possible to train a gun directly on a target, except at pointblank range; almost always the gun has to be trained or deflected somewhat from the line of sight, deliberately starting the projectile on an apparently wrong course in order to hit the target. The amount of deflection



169. EFFECT OF DRIFT ON PROJECTILE

(horizontal angle between LOS and LOD) is called sight deflection, as shown in the following illustration.



170. SIGHT DEFLECTION

Rotation and curvature of the earth may also affect the fire control problem. So far in this discussion, it has been assumed that the earth stands still and is flat. Actually, however, its movement has an effect on projectile trajectories, and its curvature has an effect on the range, but these two effects begin to be important only at extreme ranges, 30,000 yards or more.

As already mentioned, if the location and motion of a target are known, it can be determined where the target will be when the projectile hits it. After the factors which may cause a projectile to go off its course and the conditions under which a projectile has to travel have been considered, the behavior of a projectile can be predicted.

The following discussion will concern the influences of the gun itself on the flight of a projectile.

The start of a projectile determines its course. The important factors in the start of a projectile are its initial speed, also called initial velocity or I. V., and its direction. A reduced I. V. reduces range; the effect of a projectile's start in the wrong direction is obvious.

The main influences affecting a projectile's initial velocity are:

1. Wear of gun bore (erosion).
2. Variations in temperature of the propelling charge of the ammunition.
3. Variations in actual weight of the projectile.

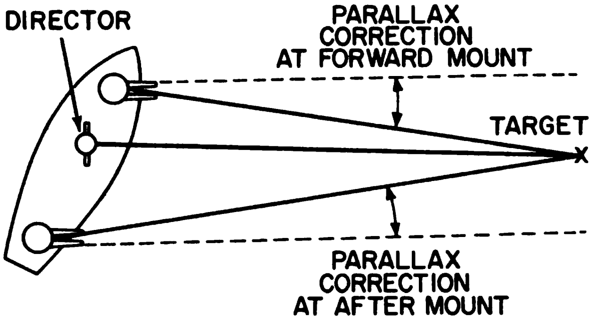
Erosion causes enlargement of the gun bore which, in turn, cuts down the initial velocity and range of the projectile and also the accuracy of fire.

By lowering the temperature of the propelling charge, the initial velocity and range of the projectile are reduced. The standard initial velocity, which is determined at the Naval Proving Grounds, is based on powder (propelling charge) temperature of 90° F. (Higher temperature increases initial velocity and range.)

Variations in projectile weights are not as important in determining I. V. as the other two factors mentioned. The values of these two factors are either built into the computer or are inputs to the computer during its operation. When all the information is supplied to the computer, it solves the gun elevation and train orders so that the gun can be laid to assure a hit.

In order for the lines of sight from two remotely located stations to converge on the same target an angular correction is necessary. This correction is called parallax. For example, illustration on facing page shows a typical ship with guns fore and aft and a midship director. If the gun train orders are based on the director's line of sight, a correction of each gun is necessary to permit all three lines of sight to converge on the target.

Parallax may be either vertical or horizontal. Horizontal parallax is more important than vertical parallax, because greater distances are involved.


DIRECTOR
PARALLAX CORRECTION AT FORWARD MOUNT
TARGET
PARALLAX CORRECTION AT AFTER MOUNT

171. HORIZONTAL PARALLAX

The horizontal angle between the bore axis of the gun and the director's line of sight is the horizontal (train) parallax. The further the gun is from the director, the greater the parallax angle for any given range. However, as range increases, parallax decreases.

Horizontal parallax correction varies with each mount, depending on the distance from mount to director. The parallax correction computed in the fire control system and transmitted to all gun mounts is the same for any given range. This correction (unit parallax) is based on the assumption that all gun mounts are one hundred yards from the director. Based on the actual horizontal distance of the director from the mount, the unit correction is converted to the proper correction by a set of change gears in each mount.

The fire control system may also compute parallax corrections for the vertical distance between guns and director. Because all guns are approximately the same vertical distance from the director, no change gears are used, and the correction is transmitted as part of the order signal(s).

Equipment used to determine various factors to be considered before firing a projectile will be discussed in Topic 2 of this section.

TOPIC 2: FIRE CONTROL SYSTEM

You Are Now Going to Learn:

1. Functions of a fire control system.
2. Location and purpose of fire control system components.
3. Flow of information in a fire control system.

Discussion Points for this Topic Are:

1. Requirements of a fire control system.
2. Location and functions of the following units:
    a. Director.
    b. Radar.
    c. Rangefinders.
    d. Stable element.
    e. Computer.
3. Functions of missile fire control computers.
4. Flow of fire control information.
5. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Optional reading list:
    a. NAVPERS 10185, GMG 3 and 2.

INFORMATION AND DISCUSSION:

In Topic 1 of this section the factors to be considered in gun laying have been discussed. In Topic 2, the major fire control units which constitute a fire control system will be explained.

Fire control systems (FCS) vary on different ships and for different gun and weapon systems. It would be impossible, in the time allotted, to describe all fire control systems; therefore, unless otherwise noted, in this topic primarily the FCS Mk 37 will be discussed. (The FCS Mk 37, which was designed to control the 5"/38 caliber gun mount, is widely used in main batteries of destroyers and in secondary batteries of many cruisers.)

A fire control system must be capable of performing the following tasks:

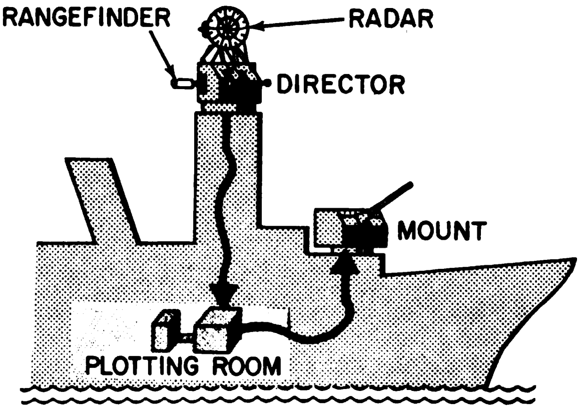
1. Locating the target.
2. Establishing target present position.
3. Predicting target future position.
4. Compensating for roll and pitch of the ship.
5. Correcting external ballistics.
6. Computing the gun or launcher elevation and train orders.
7. Computing the sight angle and sight deflection (only for some guns, not for missiles).

The four major units required to perform these tasks are listed below:

1. Director.
2. Radar and/or rangefinder.
3. Stable element or stable vertical.
4. Computer or rangekeeper.

Directors are mounted on high points of the ship (refer to the illustration on the facing page) and usually support the radar antenna and/or rangefinder. To supply the necessary energy for training the director and for controlling the optics of the director in elevation, power drives are used. The elevation power drives position the radar antennas and rangefinder prisms in step with the director optics.

Gun system directors are usually manned and can be locally controlled either by handwheels or by slew sights (one man control stations). Missile system directors are remotely controlled from control (plotting)



172. FIRE CONTROL SYSTEM, GENERAL ARRANGEMENT

rooms which are located below the directors. When tracking a target, the director transmits present target train and elevation bearings to the computer in the plotting room.

By means of radio echoes, radar determines the presence of objects, their ranges, bearings, and elevations. Radars aboard ship can be broadly classified either as search or as fire control radars.

Most of the search radars are capable of target detection at long ranges with fair precision. Search radars are used to provide approximate data on distant targets, to control friendly aircraft, and to serve as navigation aids.

Fire control radars are capable of determining rather precisely the range, bearing, and elevation of a target; however, fire control radars are more limited in range than search radars.

Usually, a fire control radars are mounted on the director (refer to illustration above), but on at least two presently used antiaircraft (AA) fire control systems the radar antennas are mounted on the gun mounts.

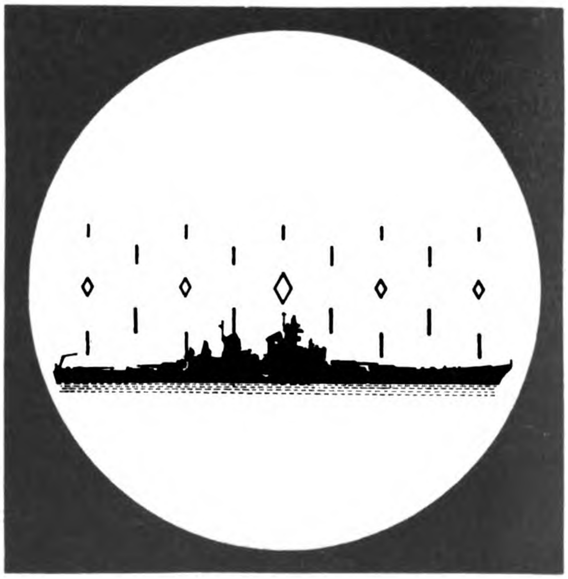
Fire control radars are classified either as surface or as antiaircraft radars. Surface radars are used primarily with main batteries of large ships, to obtain the bearing and range of surface targets (enemy ships) and for shore bombardment.

Antiaircraft radars, in addition to supplying target range and bearing data, also determine target elevation. Antiaircraft radars, except for certain types used with machinegun batteries, are capable of automatically tracking a target. During tracking of a target in automatic control, the director locks on and follows the radar signal.

Antiaircraft radars used with the fire control systems Mk 37, Mk 56, and Mk 68 (which primarily control dual purpose guns) may also be operated in a surface mode of control.

To determine target range, optical rangefinders were used long before radar was invented. Optical rangefinders consist of a system of optical units assembled in a long tube. The rangefinder tubes are still mounted in the directors of all surface fire control systems and in the AA fire control systems Mk 37 and Mk 68. Optical rangefinders all receive crosslevel signals from the stable element to keep the rangefinder tube in the horizontal plane when the ship is rolling.

Rangefinders are classified either as stereoscopic or as coincidence rangefinders. (almost all fire control system rangefinders are stereoscopic.) In a stereoscopic rangefinder, the reticle pattern is composed of ranging marks. (Refer to illustration below.)



173. RANGING MARKS

To operate a stereoscopic rangefinder, the operator must position the large center diamond, by means of a control knob, directly over the target. Then he reads the range from a dial on the rangefinder. The small diamonds are used in target spotting.

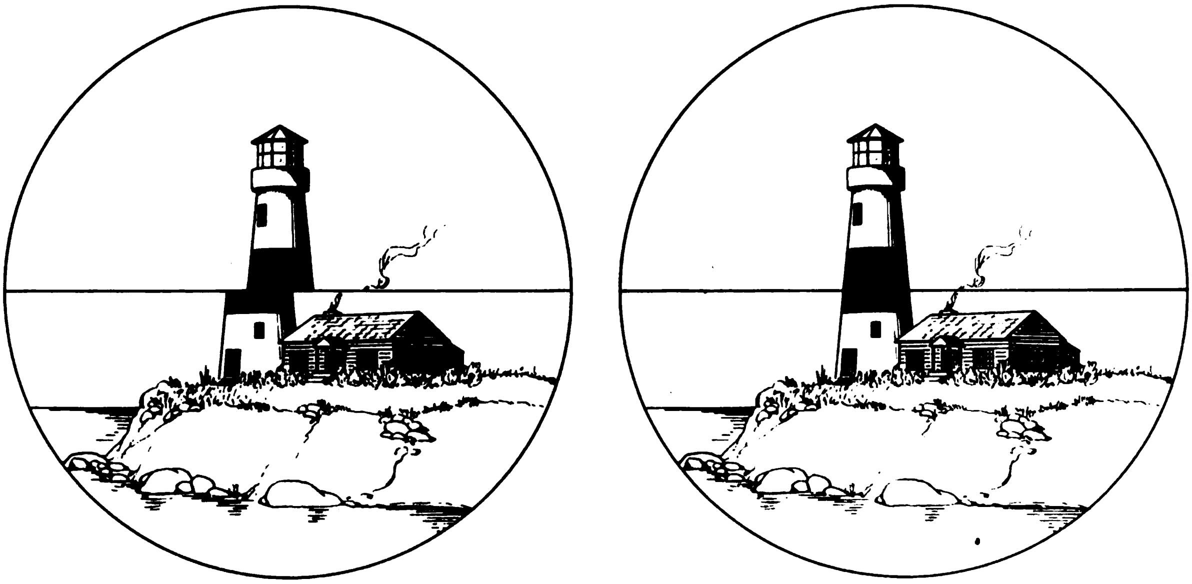
Not everyone is capable of accurately operating stereoscopic rangefinders; therefore, in the past, qualified rangefinder operators in the Navy were so important for good gunnery that they were paid extra money.

Externally, the coincidence rangefinder is similar to the stereoscopic rangefinder. The image on a coincidence rangefinder is split. (Refer to illustration below.) When the two halves of the image are properly matched, a correct range reading can be taken. Coincidence rangefinders are easier to operate than the stereoscopic type, but they are neither as accurate nor as well adapted for tracking aircraft targets as are the stereoscopic ones. Besides, coincidence rangefinders are almost useless for spotting.

The stable element is located in the plotting room (refer to illustration on following page) and, by means of a gyro, measures the roll and pitch of the ship. The resultant signals, level (in the line of sight) and cross-level (across the line of sight), are then transmitted to the computer where these signals are used to compensate for roll and pitch so that the guns and optics in the director are not affected by the ship's movements.

Surface (main battery) fire control systems use an instrument called a stable vertical which is similar to the stable element, except for certain details. (Illustration on the following page shows the general configuration of the stable element used in fire control system Mk 37.)

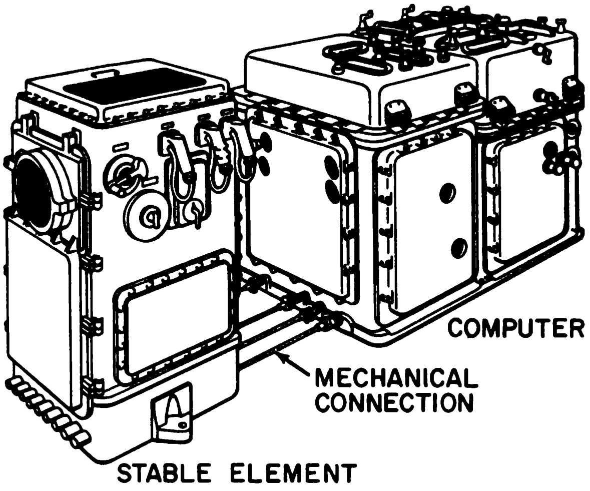
The computer, which is the heart of the fire control system, is located in the plotting room. Computers can be either of mechanical or of electronic type, or a combination of both types. The computer solves from input information the fire control problems. The solutions appear in the form of electrical output signals which control gun laying, director operation, and sighting (in gun and director).



IMAGES NOT IN COINCIDENCE

COINCIDENCE ACHIEVED

174. COINCIDENCE RANGEFINDER IMAGE



175. FIRE CONTROL SYSTEM MK 37, STABLE ELEMENT AND COMPUTER

In fire control systems that control guns which fire projectiles fitted with time fuzes, the computer must also generate fuze setting time which is determined by the future range of the target. Computers used in surface fire control systems perform the same basic operations as antiaircraft fire control computers, only the surface computers are called rangekeepers.

Missile fire control system computers are more complicated and compute more data than gun fire control system computers. Certain types of computers are capable of solving gun and missile control problems simultaneously.

The following is a list of typical functions of a missile fire control system computer:

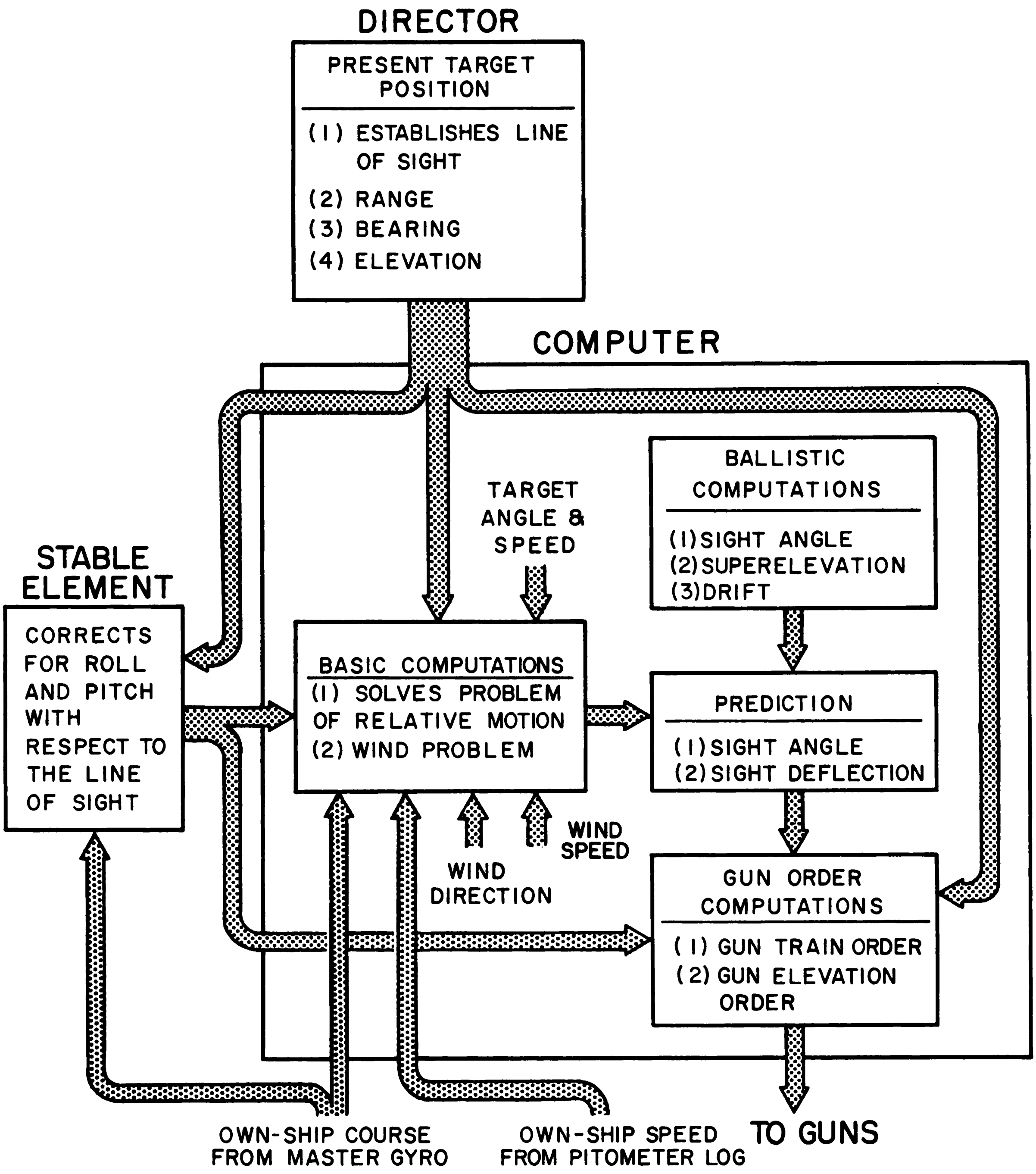
1. Control of director during target acquisition.
2. Control of launcher in train and elevation during target tracking.
3. Generation of roll gyro correction signals for the missile while the missile is on the launcher.
4. Generation of roll correction signals for orientation of the capture and guidance beams.
5. Computation of present and future target positions and effective missile range for prefiring evlauation.
6. Computation of director busy-time (estimated and computed time from the instant the target is assigned until a kill is made).

Illustration on page 274 shows a simplified flow of information in a typical gun fire control system. The director locates the target and transmits the present target position to the computer. Present target position includes present range, bearing, and elevation of target. Range is actually determined by either a radar or a rangefinder located in the director.

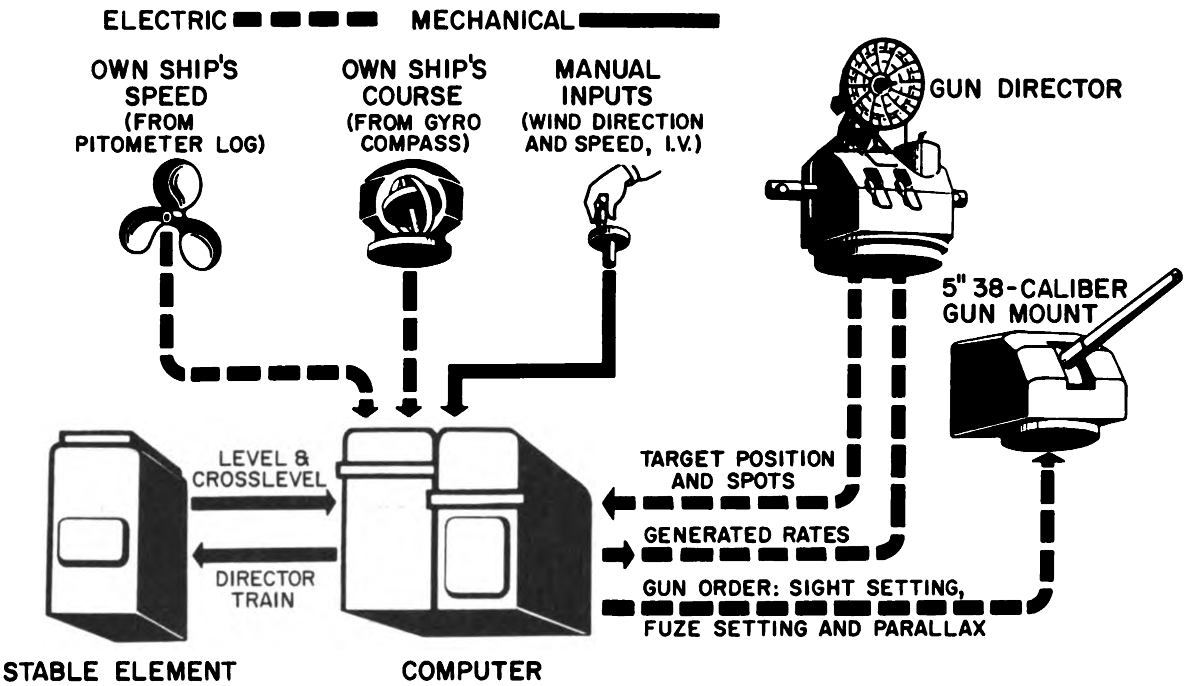
After the director has tracked the target for a very short time (usually a few seconds) the computer automatically computes the target angle and target speed. The computer then uses the present target position, target angle, and target speed plus roll and pitch, own ship speed, and own ship course, to solve the problem of relative motion between own ship and target. The relative motion problem is solved by using the vector process. This solution determines the rates of movement (changes per second) between own ship and target. The rates of movement, bearing rate, elevation rate, and range rate are transmitted to the director (refer to illustration on page 275) where, if necessary, they are corrected by the director operators.

These rate quantities are also transmitted to the prediction section of the computer where the relative motion corrections are combined with wind, drift, time in flight, and superelevation data, to determine the sight angle and sight deflection.

Sight angle, sight deflection, and the corrected target bearing and elevation angles are integrated with the roll and pitch (level and crosslevel) signals and are transmitted to the guns as sight angle, sight deflection, train order, and elevation order.



176. FIRE CONTROL SYSTEM SOLVING THE PROBLEM


ELECTRIC
MECHANICAL
OWN SHIP'S SPEED (FROM PITOMETER LOG)
OWN SHIP'S COURSE (FROM GYRO COMPASS)
MANUAL INPUTS (WIND DIRECTION AND SPEED, I.V.)
GUN DIRECTOR
5" 38-CALIBER GUN MOUNT
LEVEL & CROSSLEVEL
DIRECTOR TRAIN
TARGET POSITION AND SPOTS
GENERATED RATES
GUN ORDER: SIGHT SETTING, FUZE SETTING AND PARALLAX
STABLE ELEMENT
COMPUTER

177. FLOW OF INFORMATION IN FIRE CONTROL SYSTEM MK 37

QUIZ SHEET:

1. Standard initial velocity, determined at the Naval Proving Grounds, is based on a powder (propelling charge) temperature of

   a. 72 degrees.
   b. 65 degrees.
   c. 90 degrees.
   d. 87 degrees.

2. Wind caused by movement of both air and ship is called

   a. True wind.
   b. Relative wind.
   c. Range wind.
   d. Apparent wind.

3. Counterclockwise spin of a projectile causes the projectile to drift to the right.

   True__________or False____________.

4. Fire which is controlled from a remote control station is called

   a. Trainer fire.
   b. Master key fire.
   c. Pointer fire.
   d. Direct fire.

5. The angle between the line of sight and the line of departure is called

   a. Train angle.
   b. Target elevation.
   c. Elevation angle.
   d. Sight angle.

6. The further the gun is from the director, the greater the parallax angle.

   True__________or False____________.

7. The directors of missile fire control systems are usually manned.

   True__________or False____________.

8. Antiaircraft fire control radars differ from surface fire control radars by the feature that the antiaircraft fire control radars also transmit target elevation information.

   True__________or False____________.

9. The small diamonds (rangemarks) in stereoscopic reticles are used for

   a. Alineing.
   b. Spotting.
   c. Centering.
   d. Focusing.

10. The coincidence rangefinder is easier to use, but is less accurate then the stereoscopic rangefinder.

    True__________or False____________.

11. The stable element measures roll and pitch of a ship by means of a/an

    a. Level.
    b. Gunner's quadrant.
    c. Error recorder.
    d. Gyro.

Accuracy of notes checked by instructor.

Date____________________

Trainee's initials____________________.

TOPIC 3: INTRODUCTION TO FIRE CONTROL EQUIPMENT

You Are Now Going to Learn:

1. The purpose and application of automatic control equipment.

2. The functions of power drives used in automatic control equipment.

3. Operational sequence of signal flow.

You Will Acquire Skill in:

1. Tracing the signal flow through the components of the automatic control equipment.

Discussion Points for this Topic Are:

1. General information about automatic control equipment.

2. Purpose and functions of automatic control equipment.

3. Power drives used in automatic control equipment.

4. Sequence of signal flow.

5. Review and summary.

INFORMATION AND DISCUSSION:

The automatic control equipment to be discussed in this section comprises the train and elevation power drives for mounts, turrets, and launchers.

A power drive is a part of the basic automatic servo system. (Refer to diagram on following page and to the reference publications listed in assignment of Section 11.) Power drives can be automatically controlled from a remote station which consists of a director or computer.

The automatic control equipment is designed to comply with the nature and source of the signal, the weight of the load to be moved, and the type of damping required to eliminate random movements, to insure accuracy and rapidity of response.

The training and elevating of guns by means of manually controlled power equipment (either by matching indicating dials or by using telescopes) is relatively difficult and inaccurate. Some of the disadvantages of manual control are: Fluctuations in the incoming gun orders, inertia of heavy turrets or mounts, rolling and pitching of the gun platform, and the reaction time of the individual pointers and trainers observing and responding to order variations. These factors cause inaccuracy in gun laying which results in large dispersion in the fall of shot.

The advantages of automatic control equipment are the speed and accuracy with which guns and launchers may be laid and fired.

Automatic control is used in ordnance equipment for light loads (computers and indicators) and for heavy loads (gun mounts, turrets, fire control directors, and missile launchers). Light loads are usually driven by small electric motors; heavy loads usually require one of the following control units:

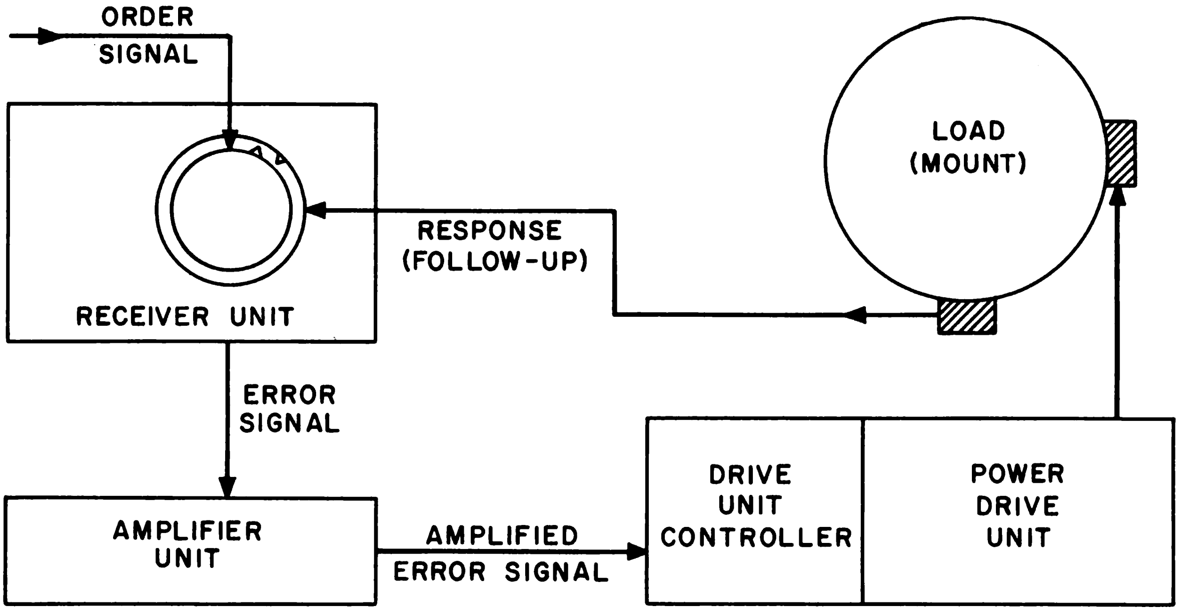
1. Electric hydraulic power drive.

2. Amplidyne power drive.

The electric hydraulic power drives are powerful, reliable, and accurate. They are mainly used for training and elevating heavy loads or where strong starting and stopping forces are involved (on ammunition hoists and rammer mechanisms). The principal disadvantage of electric hydraulic power drives is the constant maintenance they require.

The amplidyne power drives are also reliable, accurate, and require less maintenance. Amplidyne drives are superior to electric hydraulic power drives for driving lighter loads, for instance, lighter mounts and directors. At present, the largest amplidyne power drive in use is the train unit for the Mk 39, 5"/54 single mount.

The driving of a mount or director in response to a remote signal is



178. OPERATIONAL SEQUENCE OF SIGNAL FLOW OF A BASIC AUTOMATIC SERVO SYSTEM

divided into four general phases in the following sequence:

1. An order signal, received from a remote control station, is compared with the response signal or the position of the load (mount). The resulting signal is the error signal.
2. The error signal is amplified, to operate the controls of the power drive unit.
3. The power drive unit drives the load in the direction required to reduce the error signal to zero.
4. While the load is being driven, the response signal is continuously compared with the order signal.

TOPIC 4: ELECTRIC HYDRAULIC POWER DRIVES AND THEIR OPERATION

You Are Now Going to Learn:

1. The purpose and advantage of electric hydraulic power drives.
2. Operation of the train power drive for a 5"/38 twin mount.
3. Basic power drive components and their operation.

You Will Acquire Skill in:

1. Identifying the components of a power drive.
2. Tracing the operational sequence of a power drive.

Discussion Points for this Topic Are:

1. General information about electric hydraulic power drives.
2. Operation of the train power drive.
3. Components of a power drive.
4. Modes of control.
5. Practical demonstration.
6. Review and summary.

INFORMATION AND DISCUSSION:

Electric hydraulic power drives are used for moving naval gun mounts of all calibers, ranging from 40 millimeter mounts to 16 inch turrets. Electric hydraulic power drive systems are extremely intricate; their complexity grows with the increase of automation.

The main advantage of using electric hydraulic power drives is the positive control they provide at all acceleration and deceleration speeds for moving the extremely heavy units, including rotating turret structures which weigh hundreds of tons.

In this topic we will discuss a train power drive for a 5"/38 twin mount. This power drive consists of an indicator regulator and a hydraulic variable speed transmission.

The following text covers a simplified operational sequence of the train power drive.

The indicator regulator receives an order signal from a remote control station, and a mount position (response) signal from the gun. From these two signals, the indicator regulator generates an error signal which is amplified and used to control the direction and speed of the hydraulic transmission.

The indicator regulator is equipped with dials which indicate the value of the order and of the response signals.

The hydraulic speed transmission, illustrated on facing page, provides a variable speed mechanical rotary output in either direction. The transmission consists of the following major units:

1. Electric motor.
2. Reduction gears.
3. Hydraulic pump (A-end).
4. Hydraulic motor (B-end).

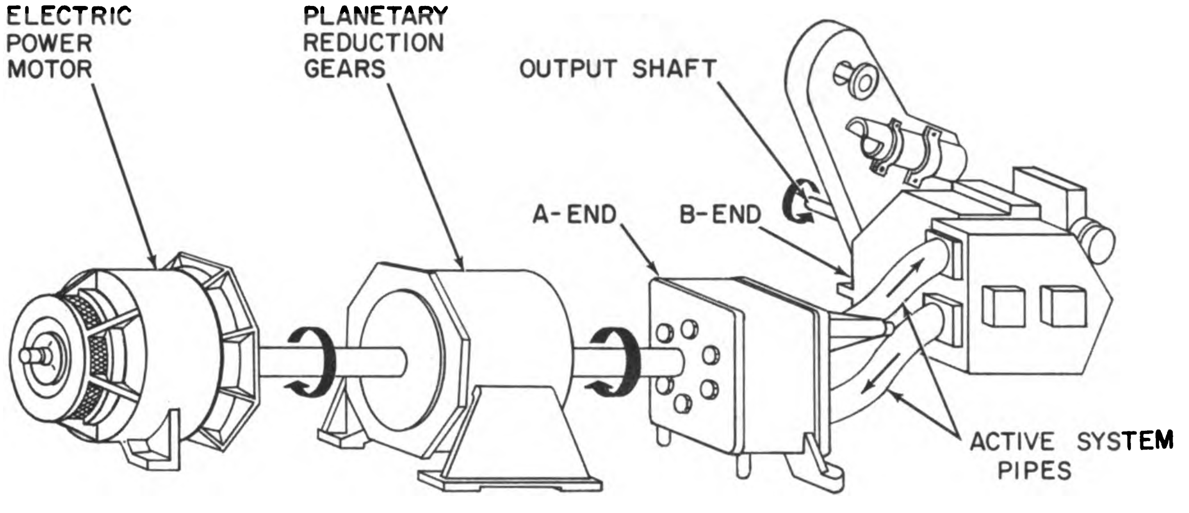
The A-end of the transmission is driven by a constant speed, one directional, 440 VAC induction type electric motor.

The reduction gear unit, located between the electric motor and the A-end, decreases the output speed of the electric motor and increases the power to drive the A-end.

The A-end hydraulically drives the B-end, and the B-end mechanically, through its gearing, trains or elevates the mount. The direction or extent of motion in train or elevation is controlled by the error signal applied to the A-end by the indicator regulator.

The train power drive system has four methods of control:

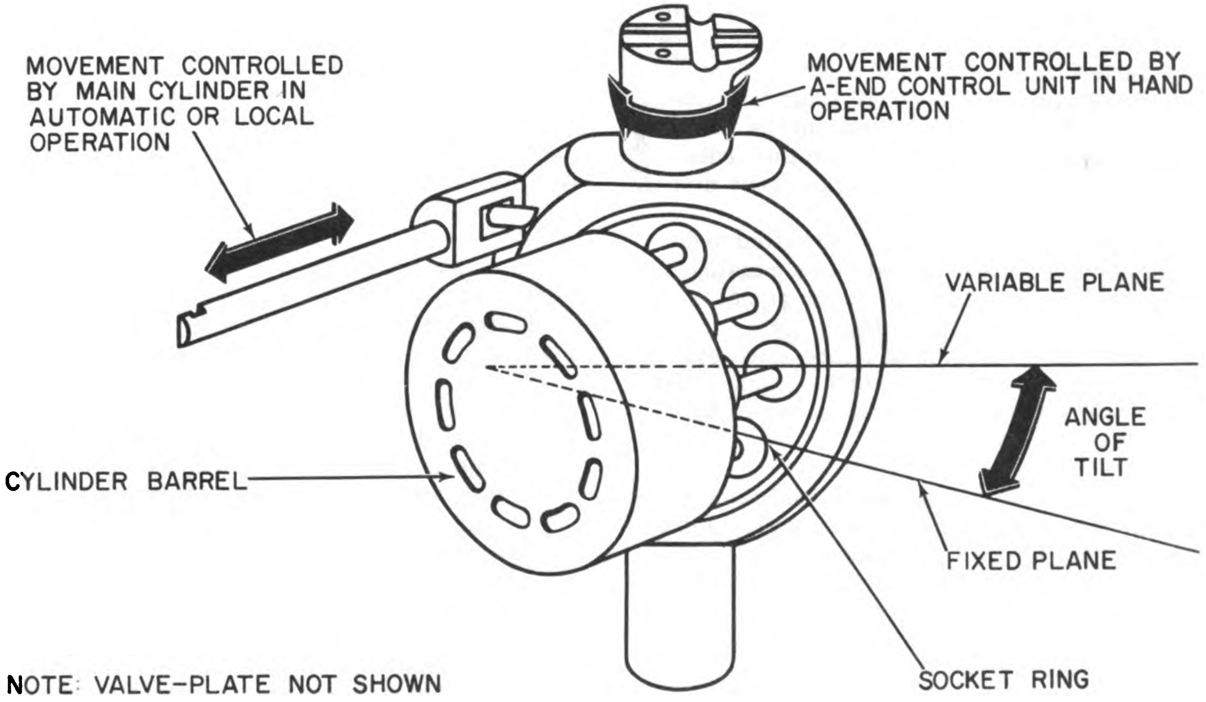
1. Automatic.
2. Local.
3. Hand.
4. Manual.



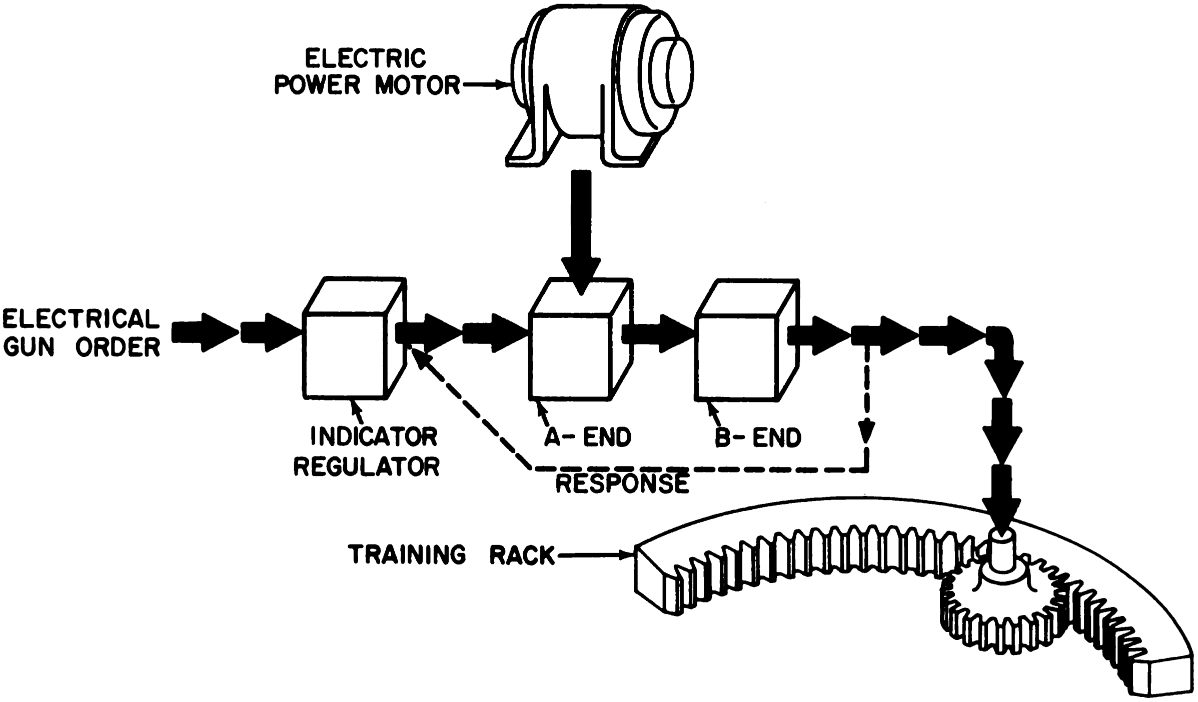
179. HYDRAULIC SPEED TRANSMISSION

The desired control method is selected by the control selector lever at the trainer's station. A two position (high and low) speed selector lever is also located at the trainer's station.

During gun laying in automatic control, as shown in illustration on page 282, the electrical order signal from a remote control station is received by a synchro receiver, is compared with the mechanical response


MOVEMENT CONTROLLED BY MAIN CYLINDER IN AUTOMATIC OR LOCAL OPERATION
MOVEMENT CONTROLLED BY A-END CONTROL UNIT IN HAND OPERATION
VARIABLE PLANE
ANGLE OF TILT
CYLINDER BARREL
FIXED PLANE
NOTE: VALVE-PLATE NOT SHOWN
SOCKET RING

180. A-END, VARYING TILT ANGLE



181. POWER DRIVE, SEQUENCE OF OPERATIONS IN AUTOMATIC CONTROL

signal, and the resulting error signal is converted by the indicator regulator into a mechanical signal which, in turn, is then converted into a hydraulic signal. (The mechanical response signal from the power drive gearing serves as input to the indicator regulator where, together with the order signal, it helps to generate the error signal.)

The hydraulic signal is amplified and then used to tilt the A-end, thus causing the power drive to follow the order signal.

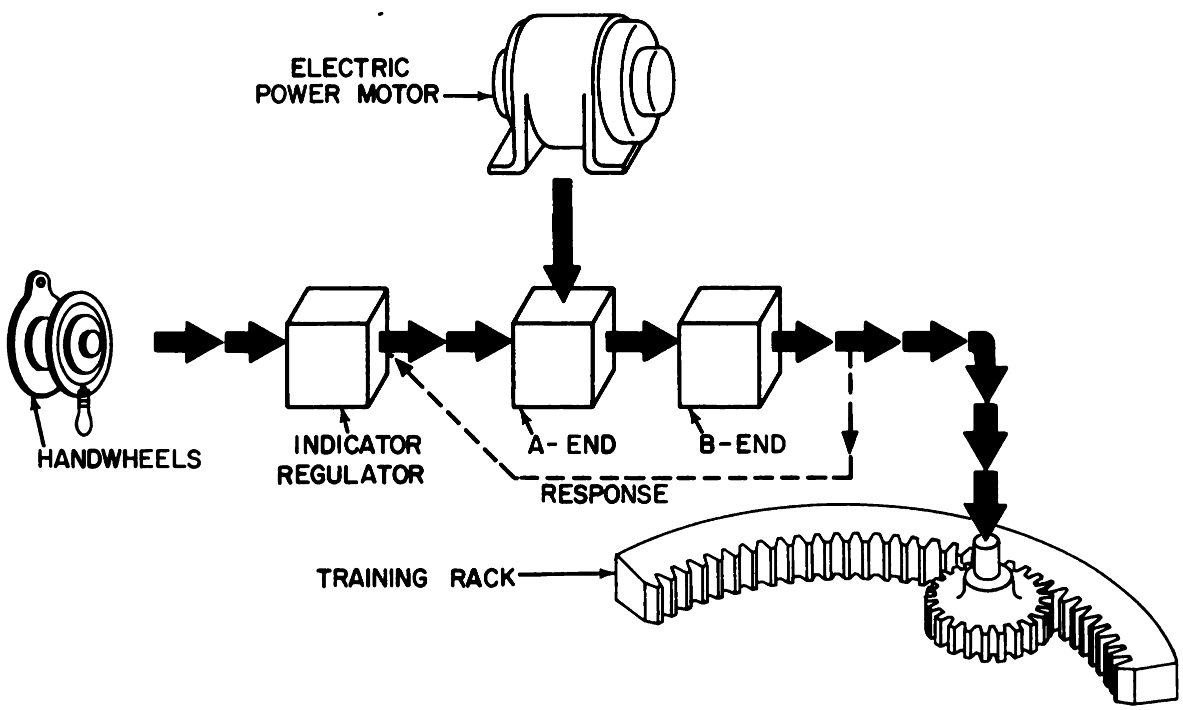
When the gun position approaches synchronization with the gun order signal, the error signal decreases until it becomes approximately zero.

In local control, as shown on facing page, the order signal is transmitted by means of the trainer's handwheels (not by a remote station) to the indicator regulator which compares the order signal with the response signal and transmits the resulting error signal to the A-end.

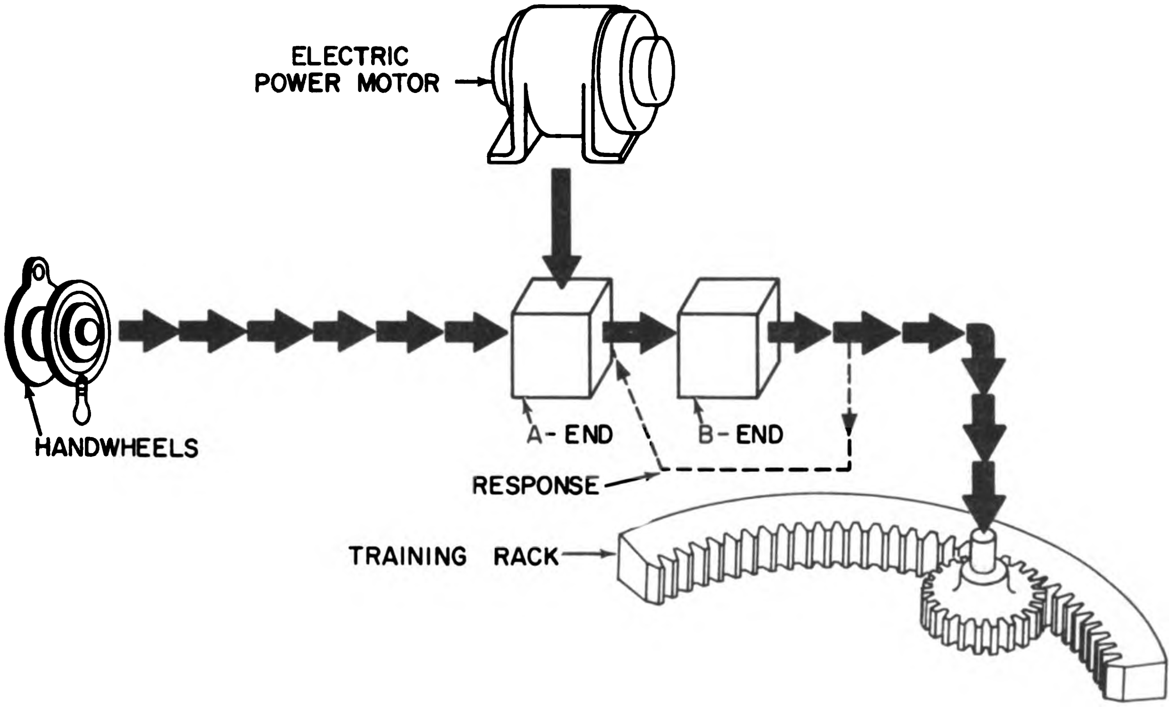
In hand control, as shown in illustration at bottom of facing page, the trainer completely bypasses the indicator regulator. The handwheels are geared to a mechanical followup system located in the A-end control unit. The A-end is powered by an electric motor. In response to the rotation of the handwheels, the A-end controls the B-end until the trainer's dial system indicates that the gun is at the position ordered. (Hand control is not available for all mounts.)

In manual control, the handwheels are geared directly to the training or elevating rack and bypass the entire electric hydraulic system.

NOTE: The control arrangements of missile launchers and certain projector types are similar in many aspects to those used in conventional guns. According to their nature and design, guided missile launching systems must be capable of operating as accurately and dependably as the newest gun systems. The construction of the power drives used depends mainly upon the weight and other physical features of particular systems.



182. POWER DRIVE, SEQUENCE OF OPERATIONS IN LOCAL CONTROL



183. POWER DRIVE, SEQUENCE OF OPERATIONS IN HAND CONTROL

TOPIC 5: AMPLIDYNE FOLLOWUP SYSTEM COMPONENTS AND OPERATION

You Are Now Going to Learn:

1. The basic components of an amplidyne followup system.
2. The operation of an amplidyne followup system.

You Will Acquire Skill in:

1. Identifying the components of an amplidyne followup system.
2. Tracing the operational sequence of train and elevation power drives on functional diagrams.

Discussion Points for this Topic Are:

1. Basic components of an amplidyne followup system:
   a. Receiver regulator.
   b. Amplifier.
   c. Amplidyne motor/generator set.
   d. DC drive motor.
2. Operation of an amplidyne followup system.
3. Modes of control of an amplidyne power drive.
4. Practical demonstration.
5. Review and summary.

INFORMATION AND DISCUSSION:

An amplidyne followup system basically consists of the following four units:

1. Receiver regulator.
2. Amplifier.
3. Amplidyne motor/generator set.
4. DC drive motor.

When the followup system is in automatic operation, each receiver regulator (one for train and one for elevation) acts as clearing house for information, and gun laying is completely automatic (requires no assistance from personnel on the mount), as illustrated by the block diagram on the facing page.

The synchro control transformer, located in the receiver regulator, receives the order signal which electrically indicates the required load position. The actual load position is determined by means of the rotor of the synchro control transformer which is rotated by the response shaft; the shaft, in turn, is geared to the load.

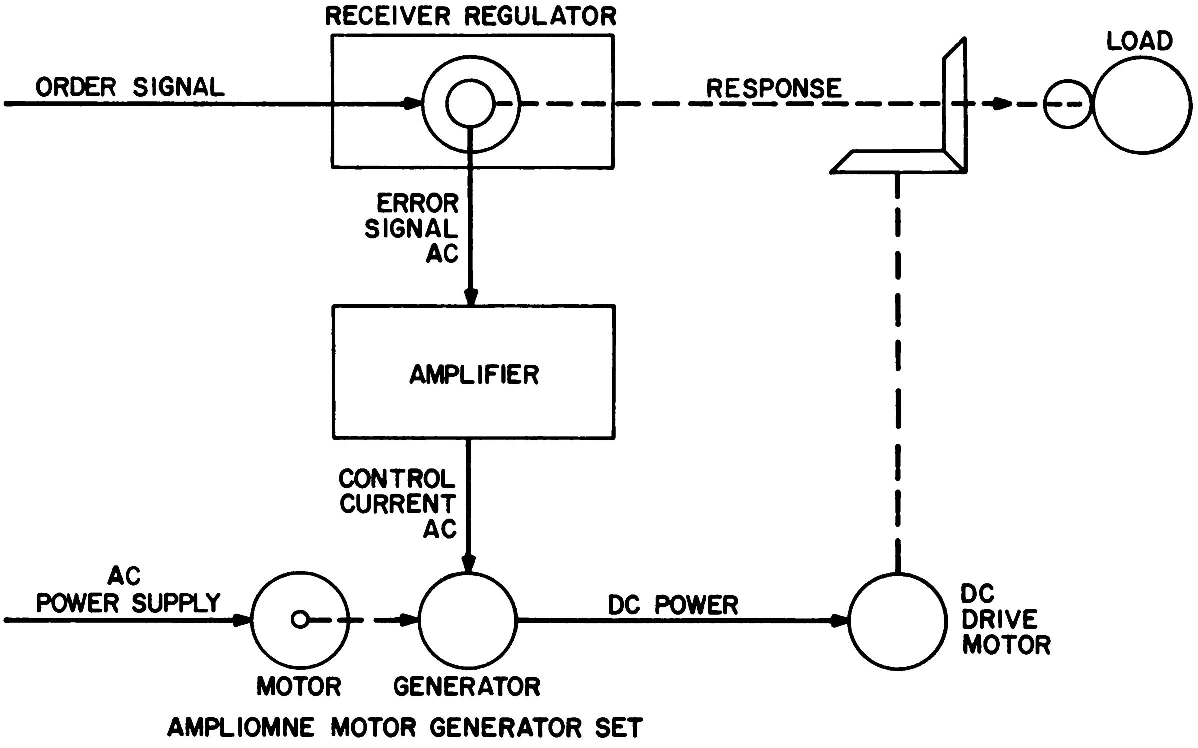
The actual load position is compared by the synchro unit with the position ordered. The angular difference between the two positions constitutes the error.

When the actual load position corresponds to the ordered position, the synchro unit performs no action; when the load position does not correspond to the ordered position, the synchro unit generates an electrical signal which is called the error signal. The error signal is then transmitted to the amplifier.

The error signal, by means of its electrical characteristics, indicates the extent and direction of the error.

The amplifier amplifies the error signal and converts it from AC to DC, to energize the field windings of the amplidyne generator.

The amplidyne motor/generator set is basically a large power amplifier. Its power output depends on the strength of its control field current. The strength of the control field current depends on the extend of the error received from the amplifier. Therefore, more power is applied to the DC drive motor for a large error signal than for a small one.



184. AMPLIDYNE FOLLOWUP SYSTEM

The DC drive motor, located on the mount, trains or elevates the guns by means of its gearing. The direct current to operate the drive motor is supplied by the amplidyne generator. The rotation direction of the motor depends on the polarity of the output of the amplidyne generator. The direction of this output, in turn, depends on the direction of the error signal. Consequently, the motor moves the load in proper direction to reduce the error.

As long as there is an order signal present, there also is an error signal. (Without an error signal, no power would be supplied to the drive motor to move the load. See the illustration on page 286.)

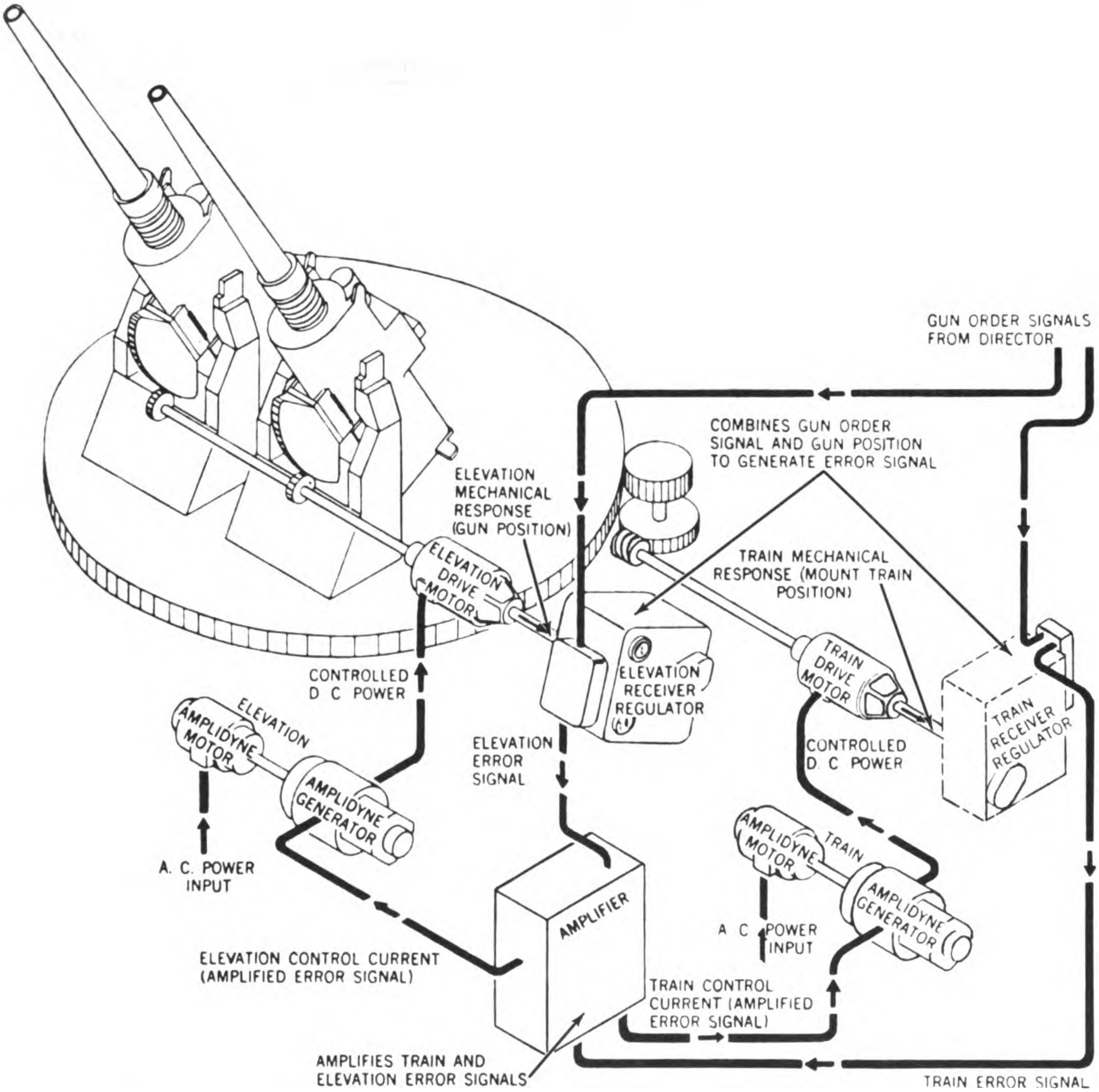
Because of the immense amplification capability of the amplidyne, the necessary power to drive the motor can be provided even when the error is extremely small.

Under normal operating conditions, the error of a load following a moving order signal is frequently so small that it is almost negligible, and the load acts as if it were geared to the order signal.

When the power drive is operated in local control, the receiver regulator functions differently than in automatic control. Its synchro unit merely generates a signal indicating the speed and direction of the moving load and transmits this signal to the control amplifier.

In addition to the load speed response signal, the control amplifier receives a speed order signal from one of the two one man control stations in the gun mount and constantly compares the actual load speed with the speed ordered. When these two speeds are alike, the control amplifier performs no action; but when they do not agree, the amplifier generates an error signal which indicates the extent of the error and the direction in which the drive motor must be rotated to reduce the error.

Since the error signal is very weak, it is amplified by the control amplifier and


GUN ORDER SIGNALS FROM DIRECTOR
COMBINES GUN ORDER SIGNAL AND GUN POSITION TO GENERATE ERROR SIGNAL
ELEVATION MECHANICAL RESPONSE (GUN POSITION)
ELEVATION DRIVE MOTOR
TRAIN MECHANICAL RESPONSE (MOUNT TRAIN POSITION)
TRAIN DRIVE MOTOR
ELEVATION RECEIVER REGULATOR
TRAIN RECEIVER REGULATOR
CONTROLLED D C POWER
ELEVATION AMPLIDYNE MOTOR
AMPLIDYNE GENERATOR
ELEVATION ERROR SIGNAL
CONTROLLED D C POWER
TRAIN AMPLIDYNE MOTOR
AMPLIDYNE GENERATOR
A. C. POWER INPUT
AMPLIFIER
A C POWER INPUT
ELEVATION CONTROL CURRENT (AMPLIFIED ERROR SIGNAL)
TRAIN CONTROL CURRENT (AMPLIFIED ERROR SIGNAL)
AMPLIFIES TRAIN AND ELEVATION ERROR SIGNALS
TRAIN ERROR SIGNAL

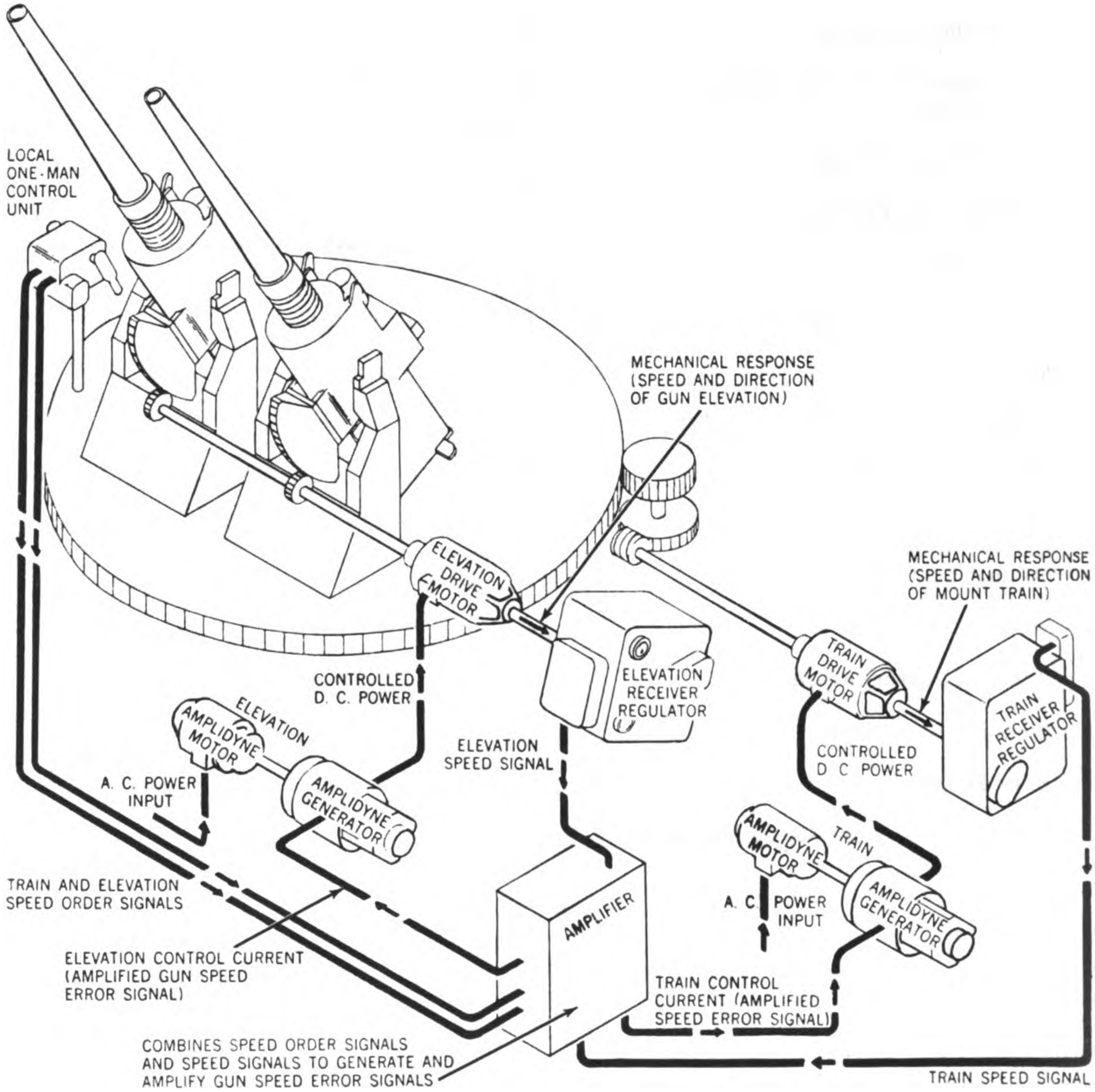
185. ELEVATION AND TRAIN POWER DRIVES, AUTOMATIC CONTROL

the amplidyne, to keep the load moving at the ordered speed.

When the speed order requests stopping of the load, the load signal becomes the error signal which now is proportionally opposite phase (or opposite direction) to the speed order signal. The error signal then starts declining as the load is coming to rest.

When the load is stopped, the error signal becomes zero, and the drive motor does not receive any power.

For the operation of the elevation and train power drives in local control, refer to illustration below.


LOCAL ONE-MAN CONTROL UNIT
MECHANICAL RESPONSE (SPEED AND DIRECTION OF GUN ELEVATION)
MECHANICAL RESPONSE (SPEED AND DIRECTION OF MOUNT TRAIN)
ELEVATION DRIVE MOTOR
TRAIN DRIVE MOTOR
ELEVATION RECEIVER REGULATOR
TRAIN RECEIVER REGULATOR
CONTROLLED D. C. POWER
ELEVATION
AMPLIDYNE MOTOR
AMPLIDYNE GENERATOR
ELEVATION SPEED SIGNAL
CONTROLLED D C POWER
A. C. POWER INPUT
TRAIN
AMPLIDYNE MOTOR
AMPLIDYNE GENERATOR
A. C. POWER INPUT
TRAIN AND ELEVATION SPEED ORDER SIGNALS
AMPLIFIER
ELEVATION CONTROL CURRENT (AMPLIFIED GUN SPEED ERROR SIGNAL)
TRAIN CONTROL CURRENT (AMPLIFIED SPEED ERROR SIGNAL)
COMBINES SPEED ORDER SIGNALS AND SPEED SIGNALS TO GENERATE AND AMPLIFY GUN SPEED ERROR SIGNALS
TRAIN SPEED SIGNAL

186. ELEVATION AND TRAIN POWER DRIVES, LOCAL CONTROL

TOPIC 6: BATTERY ALINEMENT

You Are Now Going to Learn:

1. The purpose of battery alinement.
2. Use of the borescope.
3. Adjustment to the sight setting mechanism.
4. How to tram a mount.

You Will Acquire Skill in:

1. Use of borescope.
2. Adjusting sight setting mechanism.
3. Use of tram bar.

Discussion Points for this Topic Are:

1. The purpose and scope of battery alinement.
2. Battery alinement definitions and distinctions:
3. Internal Alinement.
4. Boresight Maintenance.
5. Gunsight Alinement.
6. Bore Sighting.
7. Adjustment to sight setting mechanism.
8. Tramming.
9. Review and summary.
10. Section review.
11. Written test.

ASSIGNMENT:

A. Reference publication:

   1. Study NAVPERS 10783A, Chapter 7, pages 242 through 264.

INFORMATION AND DISCUSSION:

The discussion points listed for this topic are thoroughly covered in the reading assignment:

PERFORM THE FOLLOWING OPERATIONS:

1. Set up and use the borescope.
2. Adjust the sight setting mechanism.
3. Set up and use the tram bar.

Section 11

EXPLOSIVE ORDNANCE

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
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TOPIC 1: DEVELOPMENT OF NAVY AMMUNITION

You Are Now Going To Learn:

1. The origin of gun powder (general information).
2. The explosive reactions.
3. The classification of explosives.

Discussion Points For This Topic Are:

1. Origin of explosives.
2. General information about explosives.
3. Classification of explosives according to service use:
    a. Propellants.
    b. Initiating explosives.
    c. Burster high explosives.
    d. Auxiliary explosives.
4. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study OP 4, Volume 1, Chapter 1.
2. Optional reading list:
    a. NAVPERS 16194, Chapter 1.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 2: EXPLOSIVE MATERIALS

You Are Now Going To Learn:

1. The types, characteristics, and uses of explosives.

Discussion Points For This Topic Are:

1. Types, characteristics, and uses of black powder.
2. Types, characteristics, and uses of smokeless powder.
3. Types, characteristics, and uses of high explosives:
   a. TNT.
   b. Ammonium picrate (Explosive D).
   c. Tetryl.
   d. Tetrytol.
   e. RDX.
   f. HBX.
4. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study OP 4, Volume 1, Chapters 2, 3, and 4.
   2. Optional reading list:
      a. NAVPERS 16194, Chapter 1.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 3: GUN AMMUNITION

You Are Now Going To Learn:

1. The classification and types of naval gun ammunition.
2. The classification and purpose of primers.
3. The characteristics of propellants.

Discussion Points For This Topic Are:

1. Classification of gun ammunition.
2. Types of gun ammunition:
    a. Fixed.
    b. Semifixed.
    c. Bag.
    d. Special.
3. Purpose of primers.
4. Types of primers:
    a. Case percussion.
    b. Case electric.
    c. Case combination.
    d. Lock combination.
    e. Drill.
5. Purpose of propellent charges.
6. Characteristics of propellants.
7. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study OP 4, Volume 1, Chapters 5, 6, and 7.
2. Optional reading list:
    a. OP 2215.
    b. NAVPERS 16194, Chapter 2.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 4: PROJECTILES

You Are Now Going To Learn:

1. The types, design characteristics, and components of projectiles.
2. The identification of projectiles.

Discussion Points For This Topic Are:

1. Design characteristics and functions of the following projectile components:
    a. Ogive.
    b. Cap.
    c. False ogive or windshield.
    d. Base.
    e. Body
    f. Bourrelet band.
    g. Explosive cavity.
2. Characteristics and construction features of the following types of projectiles:
    a. Armor Piercing.
    b. Fragmenting.
    c. Special purpose.
    d. Other type.
3. Color code used for projectile identification.
4. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study OP 4, Volume 1, Chapter 9, and NAVPERS 16194, Chapter 2, pages 31 through 33.
2. Optional reading list:
    a. OP 2215.
    b. OP 2238.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 5: FUZES AND TRACERS

You Are Now Going To Learn:

1. The classification and operational principles of fuzes used by the Navy.
2. The purpose and types of tracers.

Discussion Points For This Topic Are:

1. Types and functions of fuzes.
2. Operational principles of the following types of projectile fuzes:
   a. Point detonating.
   b. Base detonating.
   c. Mechanical time.
   d. Auxiliary detonating.
   e. Proximity.
3. Types and operations of bomb fuzes.
4. Types and operations of rocket fuzes.
5. General information about various types of missile fuzes.
6. Purpose and types of tracers.
7. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study OP 4, Volume 1, Chapter 8.
   2. NAVPERS 10784, Chapter 3, pages 41 through 43.
   3. NAVPERS 16194, Chapter 2, pages 35 through 48.
   4. OP 2215.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 6: PYROTECHNICS

You Are Now Going To Learn:

1. The definitions, types, and uses of pyrotechnics.

Discussion Points For This Topic Are:

1. Definition of pyrotechnics.
2. Types and functions of surface pyrotechnics.
3. Types and functions of aircraft pyrotechnics.
4. Hazards of pyrotechnics.
5. Handling and stowage of pyrotechnics.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

1. Study OP 4, Volume 1, Chapter 17.
2. Optional reading list:
    a. OP 2213.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 7: BOMB TYPE AMMUNITION AND DEMOLITION EQUIPMENT

You Are Now Going To Learn:

1. The characteristics of various types of aircraft bombs.
2. The types of depth charges and their firing mechanisms.
3. The types of missile warheads.
4. The types and uses of demolition charges and demolition equipment.

Discussion Points For This Topic Are:

1. Types, construction features, and uses of bombs and their fillers.
2. Types and characteristics of depth charges.
3. Depth charge firing mechanisms.
4. General information about various types of missile warheads.
5. Functions of demolition materials.
6. Types and uses of demolition devices and charges.
7. Accessories used with demolition charges and items contained in demolition outfits.
8. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study OP 4, Volume 1, Chapters 13, 16, and 19, pages 19.8 through 19.12.
   2. Study NAVPERS 10784, Chapter 3, pages 38 through 41.
   3. Optional reading list:

      a. NAVPERS 16194, Chapter 4.
      b. OP 2212.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 8: ROCKETS AND SOLID FUEL ROCKET MOTORS

You Are Now Going To Learn:

1. The theory of rocket propulsion.
2. The construction features of rockets and rocket motors.
3. The characteristics of solid fuel rocket motors used for missiles.

Discussion Points For This Topic Are:

1. Theory of rocket propulsion.
2. Stabilization of rockets in flight.
3. Classification of rockets by various types.
4. Types and construction features of rocket heads.
5. Types and construction features of rocket motors.
6. Review and summary.

ASSIGNMENT:

A. Reference publications:

   1. Study OP 4, Volume 1, Chapters 12 and 19, pages 19. 2 through 19. 4.
   2. Study NAVPERS 16194, Chapter 6, pages 105 through 117.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 9: TESTS AND INSPECTIONS

You Are Now Going To Learn:

1. The procedures of visual observation, inspection, and examination of ammunition onboard naval vessels.

2. The purpose of and procedures for conducting the 65.5°C. surveillance test of smokeless powder.

Discussion Points For This Topic Are:

1. Purpose of daily inspection of magazines.

2. Methyl violet paper test:

   a. Principles of test.
   b. Types of paper used.
   c. Objects of test.
   d. Methods of conducting test.
   e. Reports.

3. Monthly examination of replacement samples and smokeless powder charges.

4. Surveillance of other types of ammunition.

5. 65.5°C. surveillance test of smokeless powder:

   a. Frequency of tests.
   b. Principles of tests.
   c. Test equipment.
   d. Methods of conducting tests.
   e. Reports and action required.

6. Review and summary.

ASSIGNMENT:

A. Reference publication:

   1. Study OP 4, Volume 2, Chapters 5 and 6.

INFORMATION AND DISCUSSION:

The discussion points listed in this topic are thoroughly covered in the assignment.

TOPIC 10: HANDLING TECHNIQUES AND SAFETY PRECAUTIONS

You Are Now Going To Learn:

1. The regulations and safety precautions for handling ammunition.
2. The regulations for stowage of ammunition.
3. The use of special equipment for handling ammunition.
4. The hazards prevalent in conventional explosives used in nuclear weapons.

Discussion Points For This Topic Are:

1. General requirements and safety precautions for handling ammunition.
2. Personnel and supervisor requirements.
3. Handling instructions for specific types of ammunition.
4. Use of ammunition handling equipment and special techniques for handling ammunition.
5. Ammunition stowage requirements.
6. Hazards prevalent in conventional explosives used in nuclear weapons.
7. Review and summary.
8. Section review.

ASSIGNMENT:

A. Reference publications:

   1. Study OP 4, Volume 2, Chapters 2, 4, and 10.
   2. Study NAVPERS 16194, Chapters 8 and 10.

INFORMATION AND DISCUSSION:

Requirements and precautions relating to nonnuclear ammunition are adequately covered in the above reading assignment.

Since nuclear weapons contain conventional explosive materials in lethal quantities, all of the techniques and safety precautions for thin cased bomb type ammunition must be considered applicable to handling of nuclear weapons.

Nuclear weapons also contain radioactive materials and may contain chemically poisonous materials; under normal circumstances and when handled according to specified procedures, these materials offer no personnel hazards. To insure against such hazards and to insure reliability, nuclear weapons are handled only by trained and authorized personnel who know and follow authorized procedures.

Under abnormal circumstances, for example, when a weapon is dropped, mechanically damaged, enveloped in flames, or involved in an explosion, special hazards may exist. Some of the unpleasant possibilities follow:

1. Explosion or burning of high explosives.
2. Scattering of pieces of high explosives as a result of breakup of the weapon.
3. Spread of radioactive materials and/or chemical poisons (in the form of particles or fumes) due to explosion, breakup, or burning of the weapon.
4. Increased radioactivity levels in the vicinity of the weapon proper.

These hazards suggest that the following common sense rules be observed by personnel who may be casually associated with nuclear weapons but who are not trained and authorized to handle them.

1. Under normal circumstances: leave the weapon alone.
2. In case of an accident or fire:

   a. Give the alarm and offer your assistance.

b. If there are qualified personnel on hand to handle the situation without your assistance, get out of the way promptly; spectators are not required!

c. In any case, stay out of the smoke from a fire which involves a nuclear weapon.

QUIZ SHEETS:

1. High speed develops maximum pressure in an explosive and produces a shattering effect which is called

   a. Velocity.
   b. Pressure.
   c. Brisance.
   d. Reaction.

2. A high explosive is a substance which can be easily detonated by a blow or shock.

   True__________ or False_________.

3. Which of the following is not a high explosive?

   a. Smokeless powder.
   b. HBX.
   c. TNT.
   d. Ammonium picrate.

4. Mercury fulminate is classified as an initiating explosive.

   True__________ or False_________.

5. An explosive mixture is a homogeneous substance whose molecules contain the oxygen, carbon, and hydrogen required for either a partial or complete combustion.

   True__________ or False_________.

6. The 5"/38 caliber guns are classified as

   a. Small arms.
   b. Minor caliber guns.
   c. Medium caliber guns.
   d. Major caliber guns.

7. The barrel length of a 5"/38 caliber gun is__________inches.

8. Gun ammunition with separate projectiles, primers, and propellants located in plugged cartridge cases is classified as

   a. Semifixed.
   b. Fixed.
   c. Bag.
   d. Special.

9. Saluting cartridges are loaded with

   a. Smokeless powder.
   b. Black powder.
   c. HBX.
   d. RBX.

10. A lock combination primer is used with bag ammunition.

    True__________or False_______.

11. The forward bearing surface of a projectile is called

    a. Bourrelet.
    b. Rotating band.
    c. Ogive.
    d. Body.

12. The projectile used to scatter metal foil in the air is called

    a. Common.
    b. Illuminating.
    c. High Capacity.
    d. Window.

13. Projectiles which possess antiaircraft characteristics and the toughness required to penetrate steel plating are called____________________projectiles.

14. Indicate the colors of a common projectile loaded with Explosive D.

    a. Body color:____________.
    b. Nose color:____________.

15. Black powder is very sensitive to friction and shock, sparks and flame.

    True__________or False_______.

16. The principal constituent of smokeless powder is

    a. Diphenylamine.
    b. Dinitrotoluene.
    c. Dibutylphthalate.
    d. Nitrocellulose.

17. Which type of smokeless powder contains nitroglycerin?

    a. SPD.
    b. SPDN.
    c. SPCG.
    d. SPDF.

18. Which type of smokeless powder is generally used for target practice?

    ______________________________.

19. The major part of high explosives is derived from coal-tar products.

    True________or False________.

20. Which high explosive is used as a standard for comparing other high explosives?

    a. Nitroglycerin.
    b. TNT.
    c. Explosive D.
    d. RDX.

21. The most important high explosive recently developed is

    a. TNT.
    b. Explosive D.
    c. Tetryl.
    d. RDX.

22. The fuzes of most types of projectiles are armed by setback and____________.

23. Setback occurs when the projectile, after it is fired, strikes an object.

    True________or False________.

24. The bomb type mechanical time fuze is primarily used in

    a. Depth bombs.
    b. Armor Piercing bombs.
    c. Incendiary bombs.
    d. Semiarmor Piercing bombs.

25. In spin stabilized rockets, nose fuzes are armed by centrifugal force.

    True________or False________.

26. The color of a smoke hand signal for day distress is

    a. White.
    b. Black.
    c. Red.
    d. Orange.

27. The 7.2-inch projector charge has a split tail ring.

    True________or False_______.

28. The propellant used in rocket motors is a double base smokeless powder consisting of nitrocellulose and ______________ ____________.

29. Armor Piercing bombs are thickwalled bombs filled with Explosive D and equipped with nose fuzes.

    True________or False_______.

30. The booster extender arms Depth Charges Mk 6 and Mk 9 by hydrostatically extending the booster to envelop the__________________________.

31. How often shall powder replacement samples be inspected?

    a. Daily.
    b. Weekly.
    c. Monthly.
    d. Yearly.

32. The purpose of the methyl violet paper test is to provide a continuous visual indication of

    a. Powder stability.
    b. Powder burning rate.
    c. Powder age.
    d. Powder appearance.

33. The 65.5°C. surveillance tests of all indexes of smokeless powder shall be started

    a. Weekly.
    b. Monthly.
    c. Semiannually.
    d. Annually.

34. The 65.5°C. surveillance tests of smoke-smokeless powder in crimped cartridges are conducted by

    a. The nearest ammunition activity.
    b. Each ship.
    c. Tenders.
    d. Navy yards.

35. Pyrotechnics shall never be stowed together with other types of ammunition.

    True__________or False_______

Accuracy of notes checked by instructor:

Date________________________________

Trainee's initials_____________________

Section 12

SPRINKLING, SMOTHERING, AND QUENCHING SYSTEMS

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Gun Ammunition Sprinkling Systems	316
2.	Missile Magazine Sprinkling Systems	326
3.	Automatic Control and Warning Devices	332
4.	Missile Magazine CO_2 Smothering System	344

TOPIC 1: GUN AMMUNITION SPRINKLING SYSTEMS

You Are Now Going to Learn:

1. Purpose, types, and operations of gun ammunition sprinkling systems.
2. Routine tests and maintenance of gun ammunition sprinkling systems.

You Will Acquire Skill in:

1. Installing test castings.
2. Conducting routine tests of magazine sprinkling systems.

Discussion Points for this Topic Are:

1. Purpose of gun ammunition sprinkling systems.
2. Gun ammunition sprinkling system components and their arrangement onboard ship.
3. Construction features of the types of various hydraulic sprinkling system group control valves.
4. Construction features of the sprinkling system remote control station components.
5. Operations of sprinkling systems.
6. Tests and inspections of sprinkling systems.
7. Review and summary.

ASSIGNMENT:

A. Reference publication:

   1. Study NAVPERS 10185, pages 48 through 54.

INFORMATION AND DISCUSSION:

Ammunition sprinkling systems are used for emergency cooling of and firefighting in magazines, ready service rooms, ammunition handling spaces, turrets, and some enclosed mounts.

An ammunition sprinkling system consists of a network of pipes, secured to the overhead and connected by a sprinkling system control valve to the ship salt water fire main. The pipes have small holes which are arranged so that the water forced through them showers all parts of the magazine or ammunition handling area.

A modern sprinkling system can wet down all exposed bulkheads at the rate of 2 gallons per minute per square foot and can sprinkle the deck area at a rate of 4 gallons per minute per square foot.

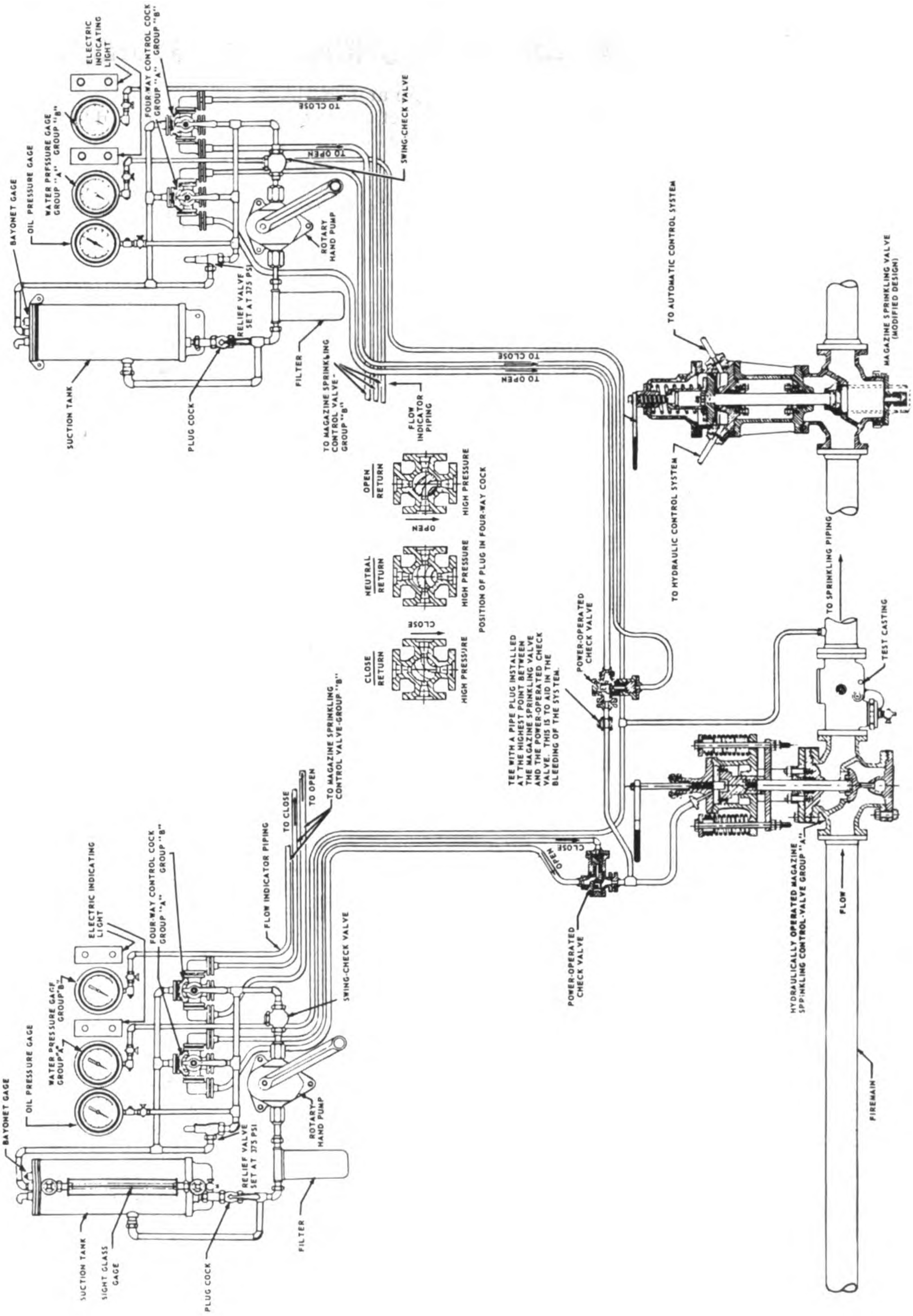
Magazine sprinkling systems are designed so that they are capable of completely flooding their designated spaces within an hour. To prevent unnecessary flooding of adjacent areas, all compartments equipped with sprinkling systems are watertight. Upper deck handling and ready service rooms are equipped with drains which limit the maximum water level to a few inches.

Magazines are completely enclosed; if flooded, they would be exposed to the full fire main pressure. The fire main pressure on most ships is considerably higher than the pressure that magazine bulkheads could withstand; therefore, magazines are equipped with exhaust ventilators, located in the bulkhead near the overhead.

An exhaust ventilator is a pipe with a check valve which permits pressure release (usually to the topside). Since the diameter of the pipe is large enough to allow water to flow out as fast as it flows in, no excess pressure can build up in the magazine compartments.

On newer ships, magazines are also equipped with small, capped drainpipes, located in the bulkhead near the deck. The caps may be removed in the adjacent compartment to drain flooded magazines.

In their complexity, the sprinkling system control valve and associated components vary with the type of ship, type of stowage, and type of ammunition stowed in the magazine.


BAYONET GAGE
OIL PRESSURE GAGE
WATER PRESSURE GAGE GROUP "A" GROUP "B"
ELECTRIC INDICATING LIGHT
FOUR-WAY CONTROL COCK GROUP "A" GROUP "B"
TO CLOSE
TO OPEN
SWING-CHECK VALVE
ROTARY HAND PUMP
RELIEF VALVE SET AT 375 PSI
SUCTION TANK
PLUG COCK
FILTER
TO MAGAZINE SPRINKLING CONTROL VALVE GROUP "B"
FLOW INDICATOR PIPING
TO CLOSE
TO OPEN
TO AUTOMATIC CONTROL SYSTEM
TO HYDRAULIC CONTROL SYSTEM
MAGAZINE SPRINKLING VALVE (MODIFIED DESIGN)
OPEN / RETURN
OPEN
HIGH PRESSURE
NEUTRAL / RETURN
HIGH PRESSURE
CLOSE / RETURN
CLOSE
HIGH PRESSURE
POSITION OF PLUG IN FOUR-WAY COCK
POWER-OPERATED CHECK VALVE
TEE WITH A PIPE PLUG INSTALLED AT THE HIGHEST POINT BETWEEN THE MAGAZINE SPRINKLING VALVE AND THE POWER-OPERATED CHECK VALVE. THIS IS TO AID IN THE BLEEDING OF THE SYSTEM.
TO SPRINKLING PIPING
TEST CASTING
TO MAGAZINE SPRINKLING CONTROL VALVE-GROUP "B"
TO OPEN
TO CLOSE
FLOW INDICATOR PIPING
CLOSE
OPEN
POWER-OPERATED CHECK VALVE
HYDRAULICALLY OPERATED MAGAZINE SPRINKLING CONTROL-VALVE GROUP "A"
FLOW
FIREMAIN
BAYONET GAGE
OIL PRESSURE GAGE
WATER PRESSURE GAGE GROUP "A"
GROUP "B"
ELECTRIC INDICATING LIGHT
FOUR-WAY CONTROL COCK GROUP "A" GROUP "B"
FLOW INDICATOR PIPING
SWING-CHECK VALVE
ROTARY HAND PUMP
RELIEF VALVE SET AT 375 PSI
FILTER
SUCTION TANK
SIGHT GLASS GAGE
PLUG COCK

187. HYDRAULIC CONTROL SYSTEM FOR OPERATING THE MAGAZINE SPRINKLING CONTROL VALVES

In ready service areas of combat ships and in certain magazines of auxiliary ships, a simple globe valve or gate valve is installed for sprinkling the magazine. This valve is manually controlled by a handwheel or some other mechanical device located outside the stowage or handling area. The control valve is connected to the handwheel by mechanical linkage (reach rods).

On combat ships, almost all gun ammunition magazines are now divided into groups. The sprinkling of each group is controlled by a master group control valve. This valve can be manually operated or can be hydraulically controlled from a remote control station. The group sprinkling control systems consist of the following components (refer to the illustration on preceding page):

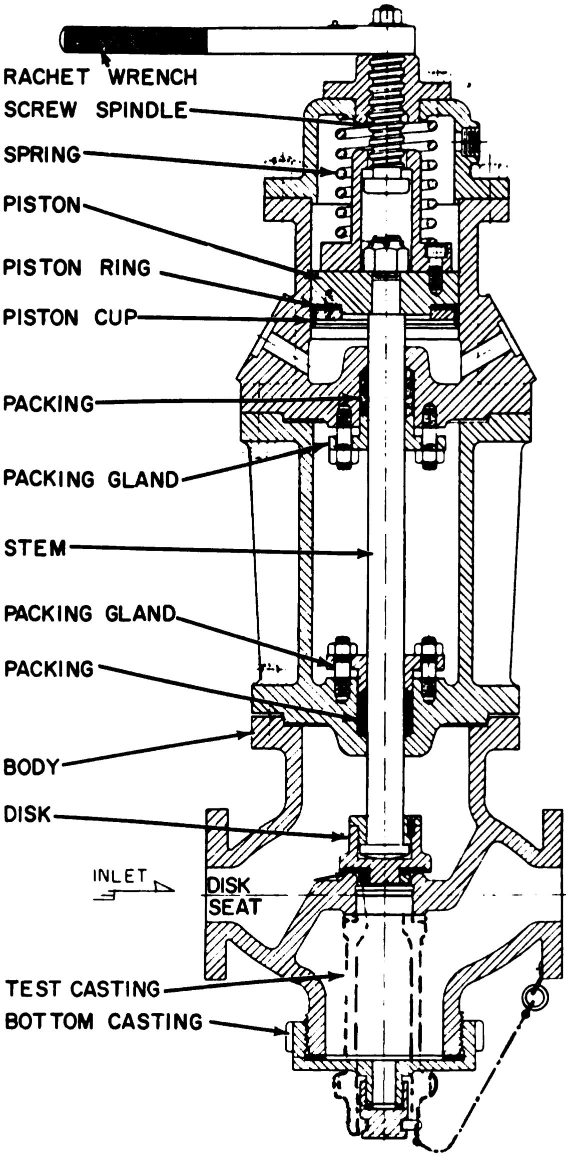
1. Group control valve (2 types).
2. Oil supply tank.
3. Filter.
4. Hand pump.
5. Swing check valve.
6. Four way control cock.
7. Relief valve assembly.
8. Power operated check valve.
9. Test casting.
10. Oil and water pressure gauges.

Two types of control valves are normally used to isolate the fire main from the sprinkler piping (commonly referred to as the dry side of the line).

The hydraulic sprinkling system control valve (shown in the illustration on adjacent column) is used on ships built after 1951. This is a piston operated globe valve, normally held closed by spring pressure acting on the piston and fire main pressure acting on the disk. When hydraulic pressure enters the underside of the piston, a force is created that overcomes both the spring tension and fire main pressure, lifting the valve disk off its seat and allowing salt water from the fire main to flow through the control valve to the sprinkling system piping. The valve is closed by spring action when the hydraulic pressure is vented from under the valve piston.

In an emergency, the control valve can be manually opened by means of a ratchet wrench.

NOTE: After opening the control valve with the ratchet wrench, the control valve screw spindle must



188. HYDRAULICALLY OPERATED CONTROL VALVE, NEW TYPE

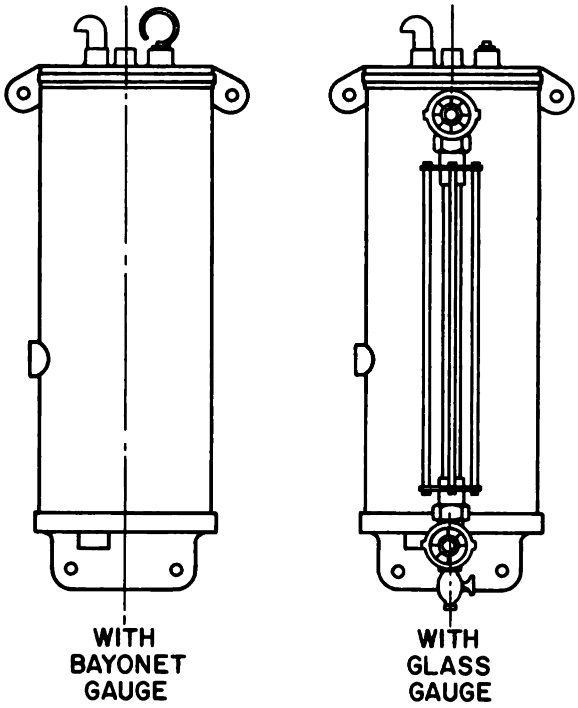
be returned, by means of the ratchet wrench, to its normal (closed) position. Next, the four way control valve at the remote control station must be returned to its closed position. The handle of the hand pump must be turned clockwise until the hydraulic pressure gauge indicates 375 psi. This action allows the hydraulic fluid under the control valve piston to return directly to tank. The full force of the control valve disk, insuring that the disk is closed.

It should also be noted that the new type group control valve has a test casting and flushing adapter built into the body of the valve.

The functions of the old type hydraulic sprinkling system control valve are similar to those of the new type control valve; however, two springs, instead of one, are utilized to close the old type valve. These springs are located outside the valve casing.

In the old type control valve, hydraulic pressure is ported to the top of the valve piston, and the disk moves down (schematically) when the valve opens. Also, the old type control valve has no flushing and test casting built into its body; therefore a special flushing and test casting is installed on the dry side of the hydraulic control valve.

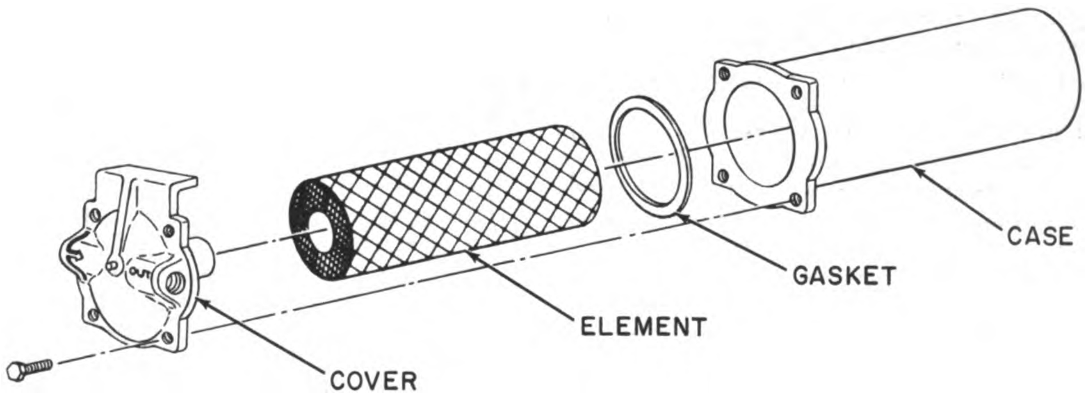
An oil supply tank, located at each remote control station, provides the hydraulic fluid for operating the sprinkling system control valve. The size of each tank depends on the size and number of valves to be operated from each control station.



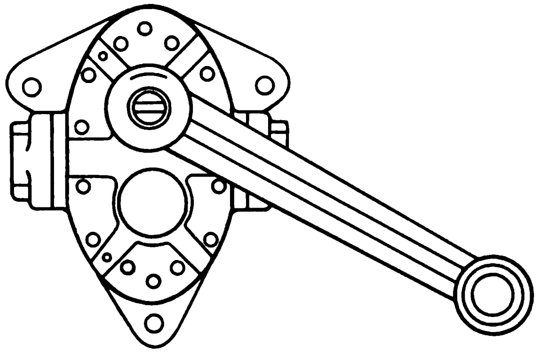
189. TYPES OF OIL SUPPLY TANKS

The types of tanks are similar, except for the oil level indicators (in one type of tank, a dipstick is used; in the other, a sight glass is installed). The average tank holds approximately two gallons of hydraulic fluid. (Refer to the illustration above.)

The filter assembly is located in the hand pump intake line at the remote control station. (Refer to the illustration below.) The assembly filters out the particles of foreign matter from the hydraulic fluid, thus



190. HYDRAULIC FLUID FILTER



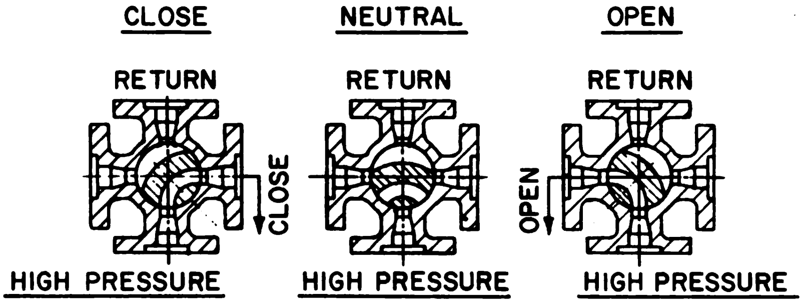
191. HAND PUMP

preventing damage to the equipment and possible interference with operation. The filter element used should be replaced at each overhaul.

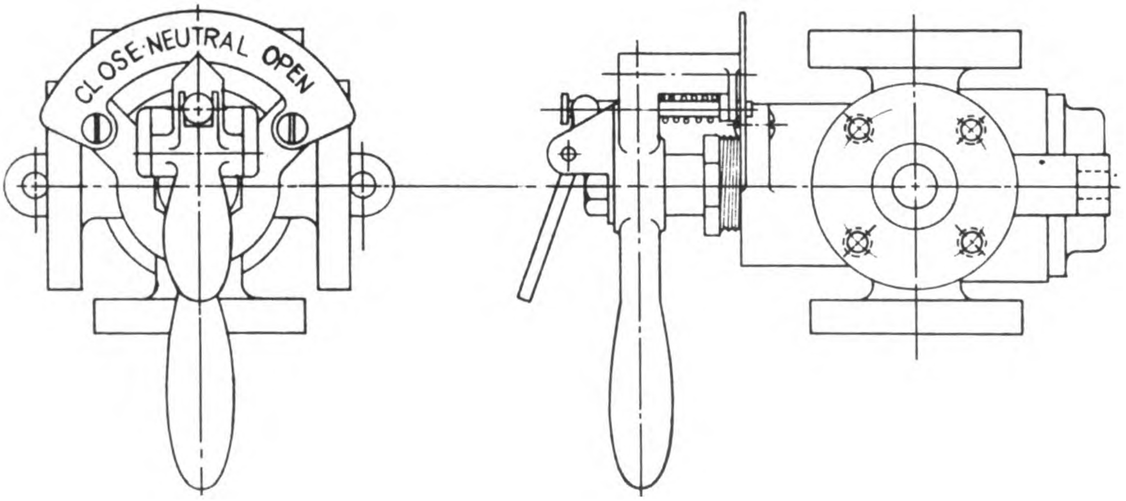
The hand pump is made of bronze. It is a rotary gear type pump which when rotated clockwise, provides the hydraulic pressure required to operate the sprinkling system. The pump handle is removable and is normally stowed on the bulkhead at the control station. (See illustration in adjacent column.)

A spring loaded swing type check valve is located in the pump output line. The valve prevents the system pressure from escaping through the pump to tank.

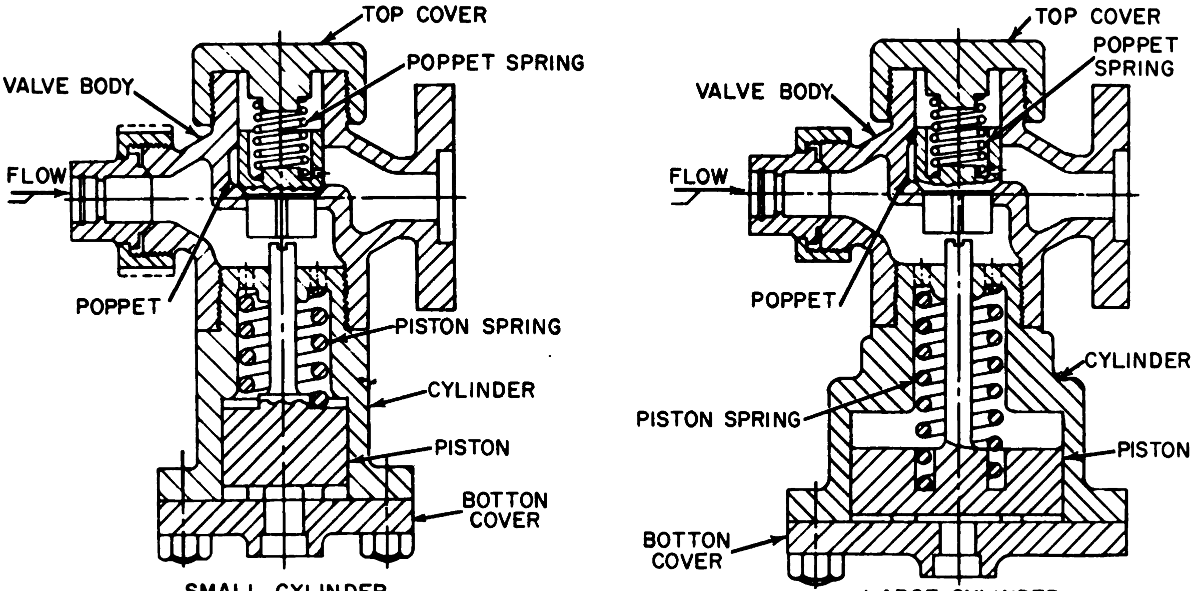
The four way control valve is located in the pump output line, between the swing check valve and the power operated check valve. (See illustration below.) The four way control valve controls the fluid flow through four hydraulic lines. The valve body (cock) is arranged so that the pressure port (pump output) can be directed either to the open port or close port of the sprinkling system. Simultaneously, the port (open port or close port which is not connected to pressure is connected to the return port (tank).



POSITION OF PLUG IN 4-WAY COCK



192. FOUR WAY CONTROL VALVE



SMALL CYLINDER

LARGE CYLINDER

193. POWER OPERATED CHECK VALVES

When the four way valve control handle is positioned to NEUTRAL, the pressure port is blocked and the close port and open port are connected to tank (return).

A spring loaded relief valve is located in the pump output line. The spring is adjusted to limit the pump output pressure to 375 psi. If the pressure in the system exceeds this amount, the relief valve lifts, to bypass the excess hand pump volume to tank.

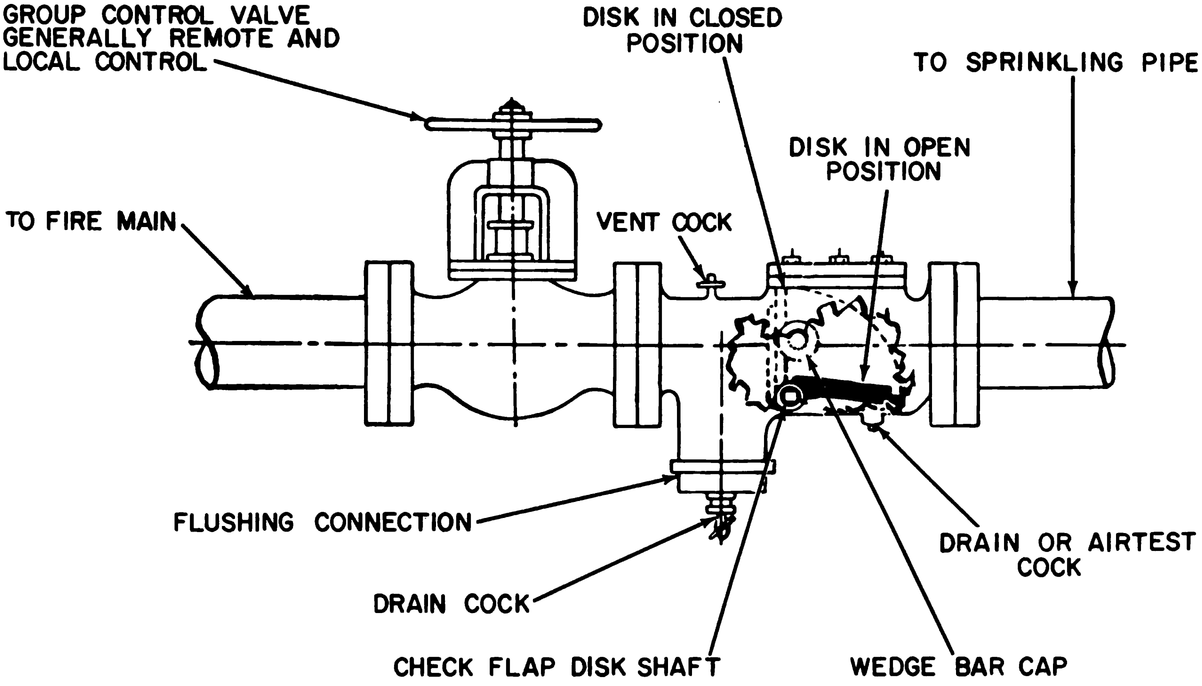
The power operated check valve is located between the four way control valve and the hydraulic sprinkling system control valve. The check valve either connects the pump output to the piston of the sprinkling system control valve or allows the hydraulic fluid from the sprinkling system control valve to return to tank.

When the four way control valve is positioned to OPEN and the pump handle is turned, hydraulic fluid from the pump is connected to the part of the power operated check valve (shown with a flow arrow in the illustration above). The pump pressure lifts the poppet, and the fluid is ported to the sprinkling system control valve. As soon as the pump is stopped, the poppet is spring returned to its seat, thus blocking the hydraulic fluid to the sprinkling system control valve and holding it open.

To close the sprinkling system control valve, the four way valve must be positioned to CLOSE, and the hand pump must be operated again. The pump output is directed to the port of the power operated check valve which is located below (schematically) the piston. The hand pump volume moves the piston up and forces the poppet off its seat, allowing the trapped hydraulic fluid from the sprinkling system control valve to return to tank, thereby enabling the spring in the sprinkling system control valve to seat the disk.

The small cylinder power operated check valve (shown above) is designed for hydraulic operation only, while the large cylinder check valve may be either hydraulically or water operated.

Test castings are used with both the old and new type sprinkling system control valves. The test castings are always located on the dry side of the control valves and provide a means of checking the sprinkling system



194. SPRINKLING SYSTEM TEST CASTING, OLD TYPE

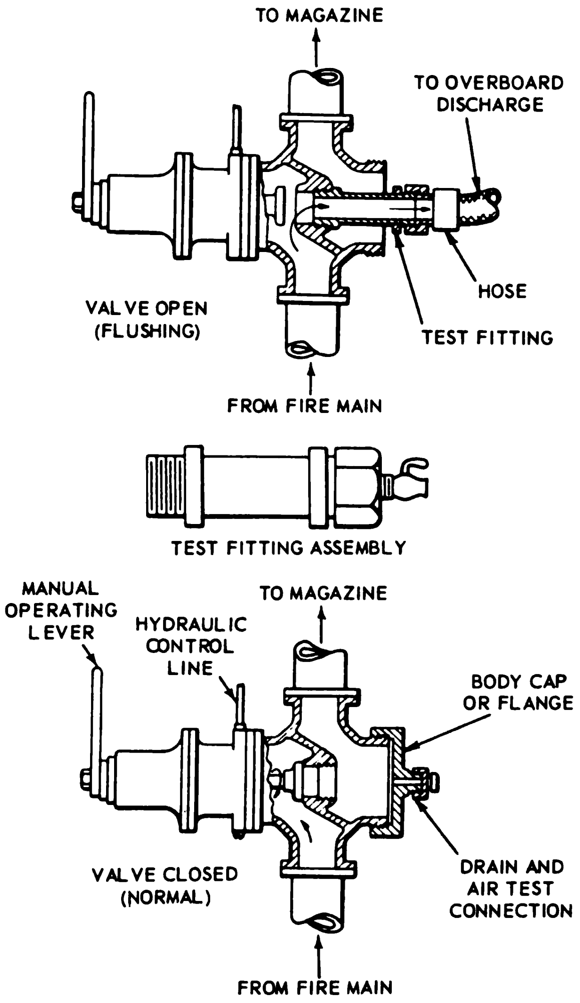
without flooding the magazine. The castings also allow flushing of the sprinkling system.

The test casting shown in the illustration above is used with the old type control valve. The disk (flapper) is closed, and a wedge bar is inserted into the casting to hold this disk closed before the sprinkling system is tested or flushed. (In the illustration above, a simple manually operated sprinkling system control valve is shown.)

The test fitting assembly for the sprinkling system new type control valve is shown in the illustration on facing page. Note that the test fitting is threaded into the control valve after the body cap has been removed. When the cap of the test fitting is removed, a hose can be connected to the fitting for flushing the sprinkling system.

Each remote control station has an oil pressure gauge installed which indicates the hydraulic pressure developed by the hand pump. In addition, some control stations also have water gauges installed which are connected to the dry side of the control valve and provide indications only when the magazine is being sprinkled.

On certain ships, light indicators are installed at the remote control stations, to indicate whether the sprinkling system control valve is open or closed. The lights are controlled by switches installed on the sprinkling control valve. Normally, either water gauges or indicating lights are used; however, a few ships have both devices installed at each remote control station.



195. TEST FITTING FOR SPRINKLING SYSTEM TESTING AND FLUSHING, NEW TYPE

The following will be a description of operational procedures for sprinkling a magazine which became overheated due to a nearby fire. It will be assumed that the sprinkling is controlled from a remote control station. (The type of sprinkling system used is shown in the illustration on following page.)

To set up the control station, the hand pump handle must be installed and the four way control valve must be positioned to OPEN, as indicated on the nameplate of the valve.

CAUTION: Some control stations may sprinkle two magazine groups; therefore, these control stations are equipped with 2 four way control valves. Care must be taken to insure against sprinkling of the wrong magazine groups.

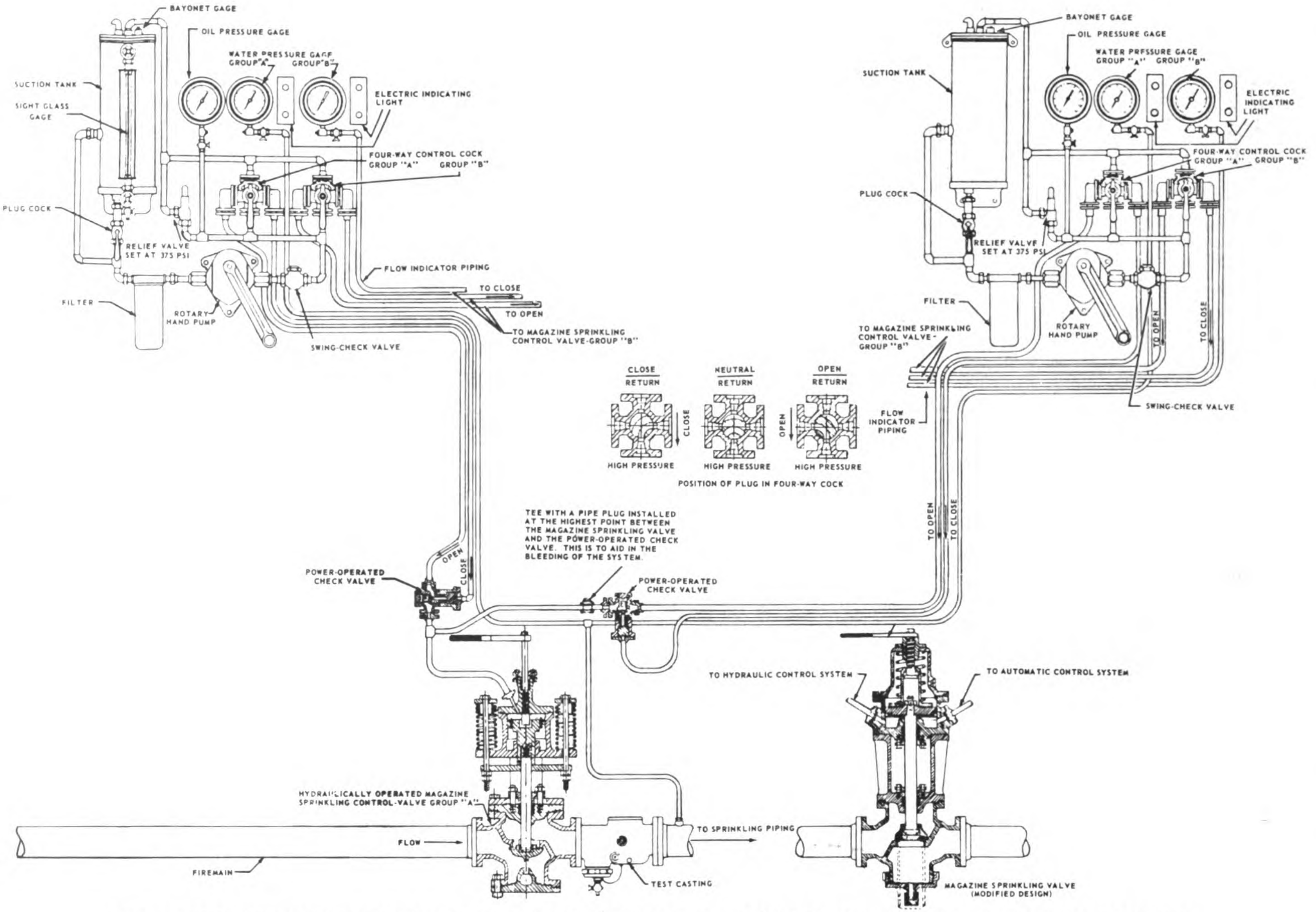
The movement of the four way valve to the OPEN position connects the hand pump output to the underside of the poppet in the power operated check valve. As the hand pump is rotated, oil in the output line moves the poppet up and is transmitted to the sprinkling system control valve piston. In the old type control valve, the hydraulic pressure developed by the hand pump forces the piston down against its springs, allowing salt water from the fire main to enter the sprinkling system pipes and to cool the magazine.

When the piston has moved the maximum allowed distance, pressure in the hydraulic system reaches 375 psi and any further hand pump output is bypassed through the relief valve to the supply tank.

When the hand pump is stopped, the sprinkling system control valve remains open, because the power operated check valve poppet is seated, blocking flow to the sprinkling system control valve piston. If a water gauge is installed at the control station, it should now indicate that the magazine is being sprinkled.

To close the sprinkling system control valve, the four way control valve must be positioned to CLOSE, as indicated on the nameplate of the valve, and the hand pump must be rotated again in the clockwise direction. Hand pump output is now ported to the piston end of the power operated check valve, causing the piston to lift and forcing the poppet off its seat.

As soon as the poppet lifts, the hydraulic fluid which was holding the sprinkling system control valve open is vented to tank and the sprinkling system control valve is closed by spring action.


BAYONET GAGE
OIL PRESSURE GAGE
WATER PRESSURE GAGE
GROUP "A"
GROUP "B"
SUCTION TANK
SIGHT GLASS GAGE
ELECTRIC INDICATING LIGHT
FOUR-WAY CONTROL COCK
GROUP "A"
GROUP "B"
PLUG COCK
RELIEF VALVE SET AT 375 PSI
FILTER
ROTARY HAND PUMP
SWING-CHECK VALVE
FLOW INDICATOR PIPING
TO CLOSE
TO OPEN
TO MAGAZINE SPRINKLING CONTROL VALVE-GROUP "B"
BAYONET GAGE
OIL PRESSURE GAGE
WATER PRESSURE GAGE
GROUP "A"
GROUP "B"
SUCTION TANK
ELECTRIC INDICATING LIGHT
FOUR-WAY CONTROL COCK
GROUP "A"
GROUP "B"
PLUG COCK
RELIEF VALVE SET AT 375 PSI
FILTER
ROTARY HAND PUMP
TO OPEN
TO CLOSE
TO MAGAZINE SPRINKLING CONTROL VALVE-GROUP "B"
FLOW INDICATOR PIPING
SWING-CHECK VALVE
CLOSE
RETURN
NEUTRAL
RETURN
OPEN
RETURN
CLOSE
OPEN
HIGH PRESSURE
HIGH PRESSURE
HIGH PRESSURE
POSITION OF PLUG IN FOUR-WAY COCK
TEE WITH A PIPE PLUG INSTALLED AT THE HIGHEST POINT BETWEEN THE MAGAZINE SPRINKLING VALVE AND THE POWER-OPERATED CHECK VALVE. THIS IS TO AID IN THE BLEEDING OF THE SYSTEM.
TO OPEN
TO CLOSE
POWER-OPERATED CHECK VALVE
OPEN
CLOSE
POWER-OPERATED CHECK VALVE
TO HYDRAULIC CONTROL SYSTEM
TO AUTOMATIC CONTROL SYSTEM
HYDRAULICALLY OPERATED MAGAZINE SPRINKLING CONTROL-VALVE GROUP "A"
FLOW
FIREMAIN
TO SPRINKLING PIPING
TEST CASTING
MAGAZINE SPRINKLING VALVE (MODIFIED DESIGN)

196. HYDRAULIC CONTROL SYSTEM FOR OPERATING THE MAGAZINE SPRINKLING CONTROL VALVES

CAUTION: Care should be taken to keep the pump rotating and to maintain 375 psi on the hydraulic gauge until the salt water gauge (if installed) indicates zero.

When the sprinkling system control valve is closed, the four way control valve must be positioned to NEUTRAL. In this position, the four way valve blocks the pump output port and connects both the open port and close port to tank.

The magazine sprinkling checks and test are conducted regularly, at scheduled intervals. The following sprinkling system checks and tests are performed and recorded:

1. Daily: Petcocks on the dry side of the sprinkling system control valve (usually in the test casting) are opened to insure that the sprinkling system control valve isn't leaking. Usually, this check is made when the magazine temperatures are taken.

2. Weekly: The sprinkling system control valve is tested by using all methods of control. During this test, the magazine is prevented from being sprinkled, by wedging the flapper valve closed in the test casting (old type) or by inserting the test fitting into the control valve (new type). (Illustrations on pages 322 and 323 show the test casting, flapper valve or disk, and the test fitting.)

3. Monthly: The sprinkling system is flushed by connecting a fire hose to the test casting or test fitting and by opening the sprinkling system control valve. The flapper valve must be wedged closed on the old type test casting.

4. Quarterly: The dry side of the sprinkling system should be blown out with an airhose. With air turned on, the sprinkler pipes should be checked by running a hand along them, to insure that the holes in the sprinkler piping through which the air flows are free from obstructions.

The above checks and tests are simple by very important, since the lives of all aboard ship and the existence of the ship itself may depend on the proper functioning of the sprinkling system.

The hydraulic fluid tanks should be checked regularly to insure that they are filled to the proper level. Care should be taken that only clean fluid of prescribed type be used in the sprinkling system.

TOPIC 2: MISSILE MAGAZINE SPRINKLING SYSTEMS

You Are Now Going to Learn:

1. General arrangement and operation of missile magazine sprinkling systems.
2. Missile magazine sprinkling system tests and maintenance.

Discussion Points for this Topic Are:

1. Purpose of missile magazine sprinkling systems.
2. Missile magazine sprinkling system components, their construction features and arrangement onboard ship.
3. Operation of missile magazine sprinkling systems.
4. Sprinkling system tests and inspections.
5. Use and construction features of the water injector sprinkling system.
6. Review and summary.

INFORMATION AND DISCUSSION:

A missile magazine sprinkling system, like a gun ammunition sprinkling system, is used for firefighting or for emergency cooling. The missile sprinkling system, however, can normally be operated from several control stations or can be automatically operated. Instead of hydraulic fluid, the missile magazine sprinkling system uses fire main water pressure to open the sprinkling system main control valve.

The missile magazine sprinkling system main control valve is similar in construction to the new type control valve described in Topic 1 of this section. Fire main water pressure at 90 psi is required to cause the main control valve to lift.

A local control panel for a typical missile magazine sprinkling system mounts four manually operated valves: a manual control valve, a pressure cutoff valve, an automatic operation cutoff valve, and a pressure gauge cutoff valve. (Refer to the illustration on facing page.)

The panel also mounts five one way check valves, a hydraulically operated check valve, a pneumatically released pilot valve (PRP), and a pressure gauge.

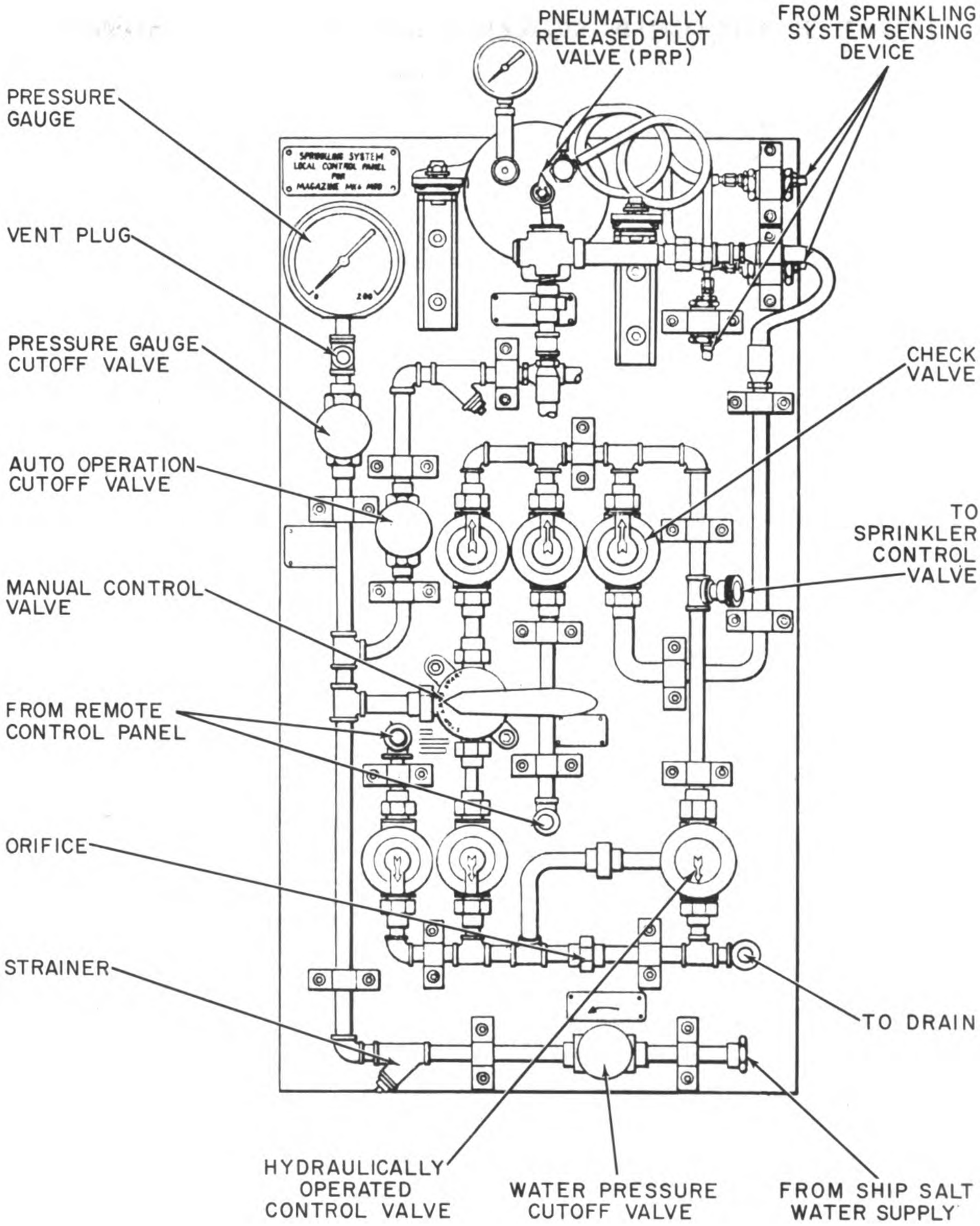
The manual control valve is a three position and a three way valve. The three positions and functions of the valve are as follows:

1. AUTO - Permits automatic operation by blocking the passage of water through a manual control valve.
2. START - Permits water from the fire main to be ported up through a one way check valve to the piston of the sprinkling system main control valve located in the magazine, thus initiating sprinkling action.
3. STOP - Permits water from the fire main to be ported down through a one way check valve to the hydraulically operated control valve (pressure operated check valve). With fire main pressure on this valve, the pressure from the sprinkling system main control valve piston is vented to tank, thus preventing any further sprinkling.

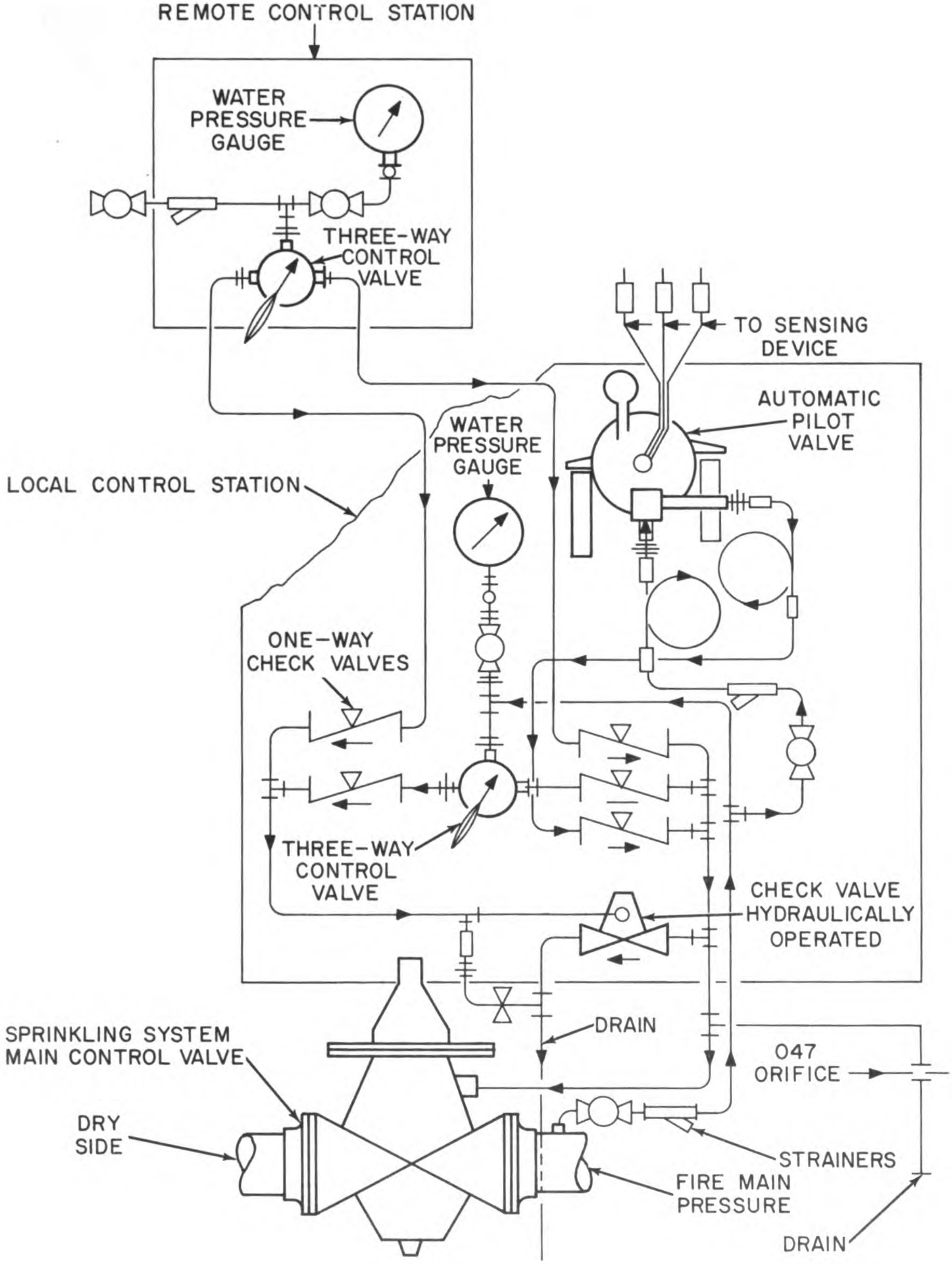
The pneumatic (air operated) pilot valve is normally closed. (Refer to the illustration on facing page.) When actuated, it directs water from the fire main to the piston of the sprinkling system main control valve. The pilot valve is actuated by sensing devices in the magazine area. (This valve and the sensing devices will be described in Topic 3 of this section.)

The pressure gauge at the control panel indicates the fire main pressure. A manually operated cutoff valve and a vent plug are provided to isolate the gauge and to vent any air trapped in the pipe leading to the gauge.

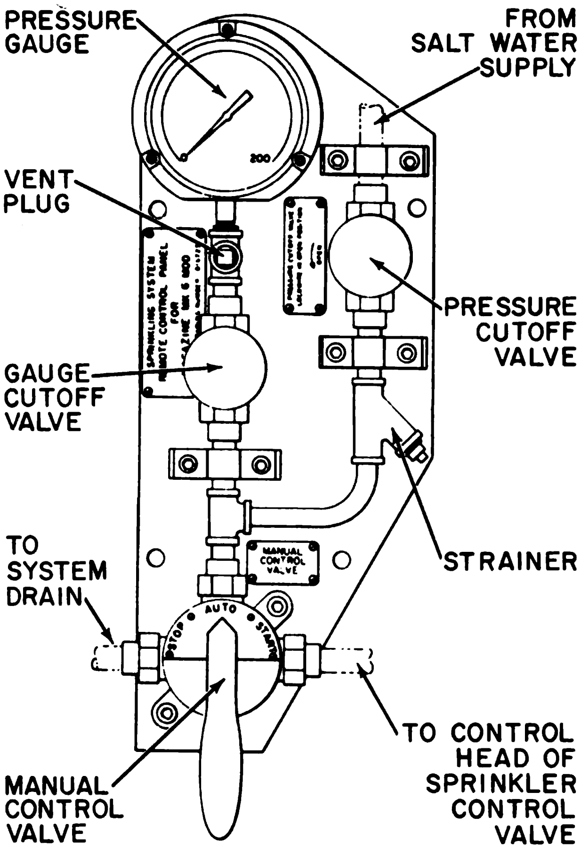
Salt water strainers are provided in the fire main input line and in the line to the


PNEUMATICALLY RELEASED PILOT VALVE (PRP)
FROM SPRINKLING SYSTEM SENSING DEVICE
PRESSURE GAUGE
VENT PLUG
PRESSURE GAUGE CUTOFF VALVE
CHECK VALVE
AUTO OPERATION CUTOFF VALVE
TO SPRINKLER CONTROL VALVE
MANUAL CONTROL VALVE
FROM REMOTE CONTROL PANEL
ORIFICE
STRAINER
TO DRAIN
HYDRAULICALLY OPERATED CONTROL VALVE
WATER PRESSURE CUTOFF VALVE
FROM SHIP SALT WATER SUPPLY

197. SPRINKLING SYSTEM, LOCAL CONTROL PANEL



198. MISSILE MAGAZINE SPRINKLING SYSTEM, SCHEMATIC



199. SPRINKLING SYSTEM, REMOTE CONTROL PANEL

automatic pilot valve (PRP). Drain cocks are usually provided to drain off any sediment collected in the strainer.

The remote control station, which works in conjunction with the local control station, consists of a gauge, fire main water pressure connection, strainer, two cutoff valves, and a three way manually operated control valve. (Refer to the illustration shown above.) The three way manually operated control valve of the remote control station functions like the manual control valve of the local control station and is also operated in the same manner.

A schematic of a typical missile magazine sprinkling system is shown in the illustration on facing page. The local control fire main pressure which operates the sprinkling system main control valve is shown leaving the wet side of the main control valve and being ported through a cutoff valve and strainer to the three way manually operated control valve and the automatic pilot valve. If the automatic pilot valve is actuated or the three way valve is positioned to START, fire main water under pressure is ported through a one way check valve to the piston in the main control valve, causing the disk to lift.

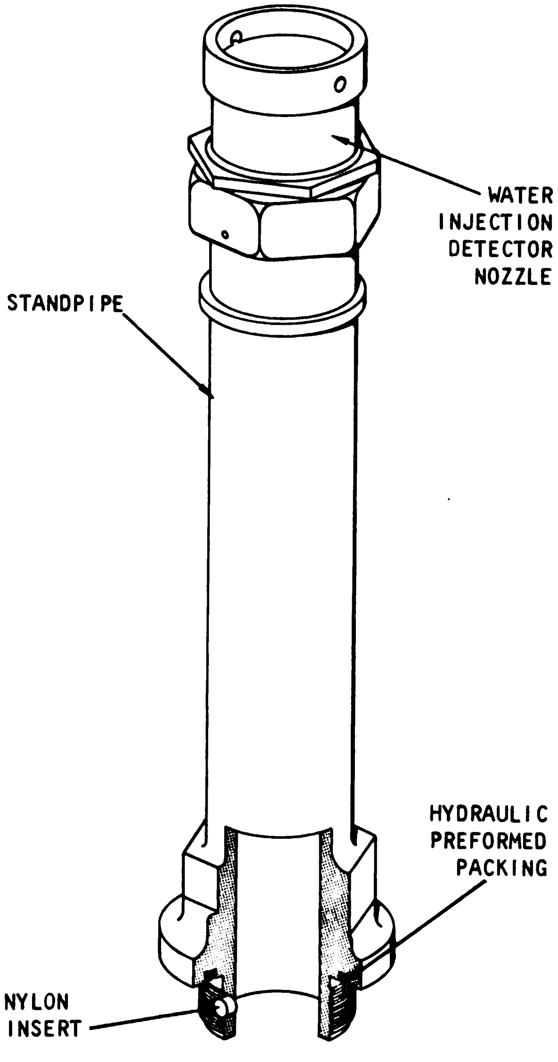
> NOTE: There are three one way check valves in the line to the main control valve piston: one for each of the two three way control valves and one for the automatic pilot valve.

Once the sprinkling system has been activated, one of the three way control valves must be positioned to STOP before the sprinkling system can be shut off. When either one of the three way valves is positioned to STOP, water from the fire main is ported to the hydraulically operated check valve, connecting the line from the main control valve piston to drain. It should be noted that there are only two one way check valves (one for each three way control valve) in the stop line; therefore, if the sprinkling system is actuated by the automatic pilot valve, the sprinkling system must be manually stopped after the emergency is over.

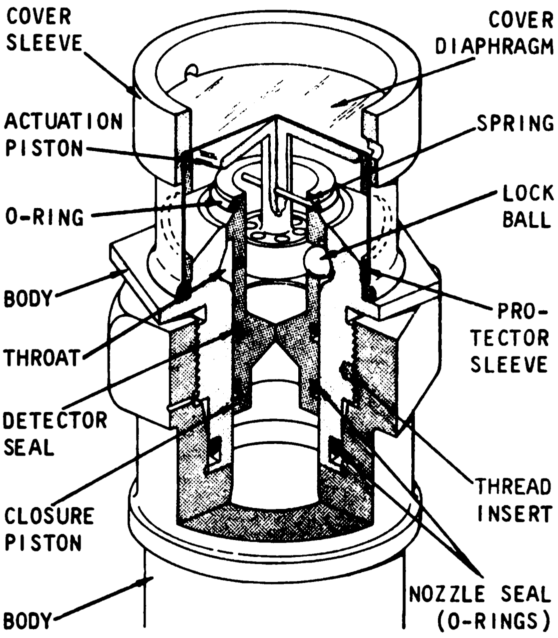
A .047 orifice and an open drain line are connected into the pressure line to the main control valve piston. The .047 orifice is too small to prevent operation of the sprinkling system, but it is large enough to prevent the water which may leak around the three way control valves and automatic pilot valve from activating the sprinkling system. Checks should be made regularly to insure that the drain is open and that the orifice is not clogged.

The missile magazine sprinkling system requires the same tests and inspections as the gun ammunition sprinkling system described in Topic 1 of this section.

Certain missile magazines use a different type of sprinkling system. These sprinkling systems are equipped with quenching heads (water injector detector nozzles, as illustrated below) which are mounted at the base of each missile in stowage. Fire main pressure is present at each head and is blocked by a closure piston. The open end of the nozzle is covered by a plastic cover/sleeve and diaphragm. The piston is locked closed by lock balls and a spring wire.



200. INJECTOR NOZZLE



201. DETECTOR NOZZLE

If a booster in the magazine would become ignited, the gas pressure developed would rupture the diaphragm and force the piston down, bending the spring wire. When the actuating piston moves down, the lock balls are freed and fire main water pressure is sprayed into the base of the missile booster. The nozzle is actuated by a pressure approximately 100 pounds.

TOPIC 3: AUTOMATIC CONTROL AND WARNING DEVICES

You Are Now Going to Learn:

1. Types, general arrangement, construction features, and operation of sprinkling system automatic control devices.
2. Tests and maintenance of sprinkling system automatic control devices.
3. Construction features and operation of sprinkling system warning devices.

Discussion Points for this Topic Are:

1. Purpose of sprinkling system automatic control devices.
2. Construction features of early model rate-of-rise sprinkling system automatic control devices.
3. Changes in design of sprinkling system automatic control devices.
4. Operation of sprinkling system automatic control devices.
5. Tests and maintenance of sprinkling system automatic control devices.
6. Purpose and use of the pry-a-larm warning system.
7. Review and summary.

INFORMATION AND DISCUSSION:

Most missile magazine sprinkling systems and some gun magazine sprinkling systems are equipped with automatic control devices. These automatic control devices are actuated by heat sensing elements located in the magazine area.

The automatic control device actuates the same sprinkling system main control valve which is operated by the hydraulic remote and local control stations. The device can be designed to actuate when a rapid rise of temperature occurs or when the heat exceeds a fixed temperature.

> NOTE: The sprinkling system described in this topic actuates at 150° F. Other systems, however, may actuate at a fixed temperature above or below 150° F.

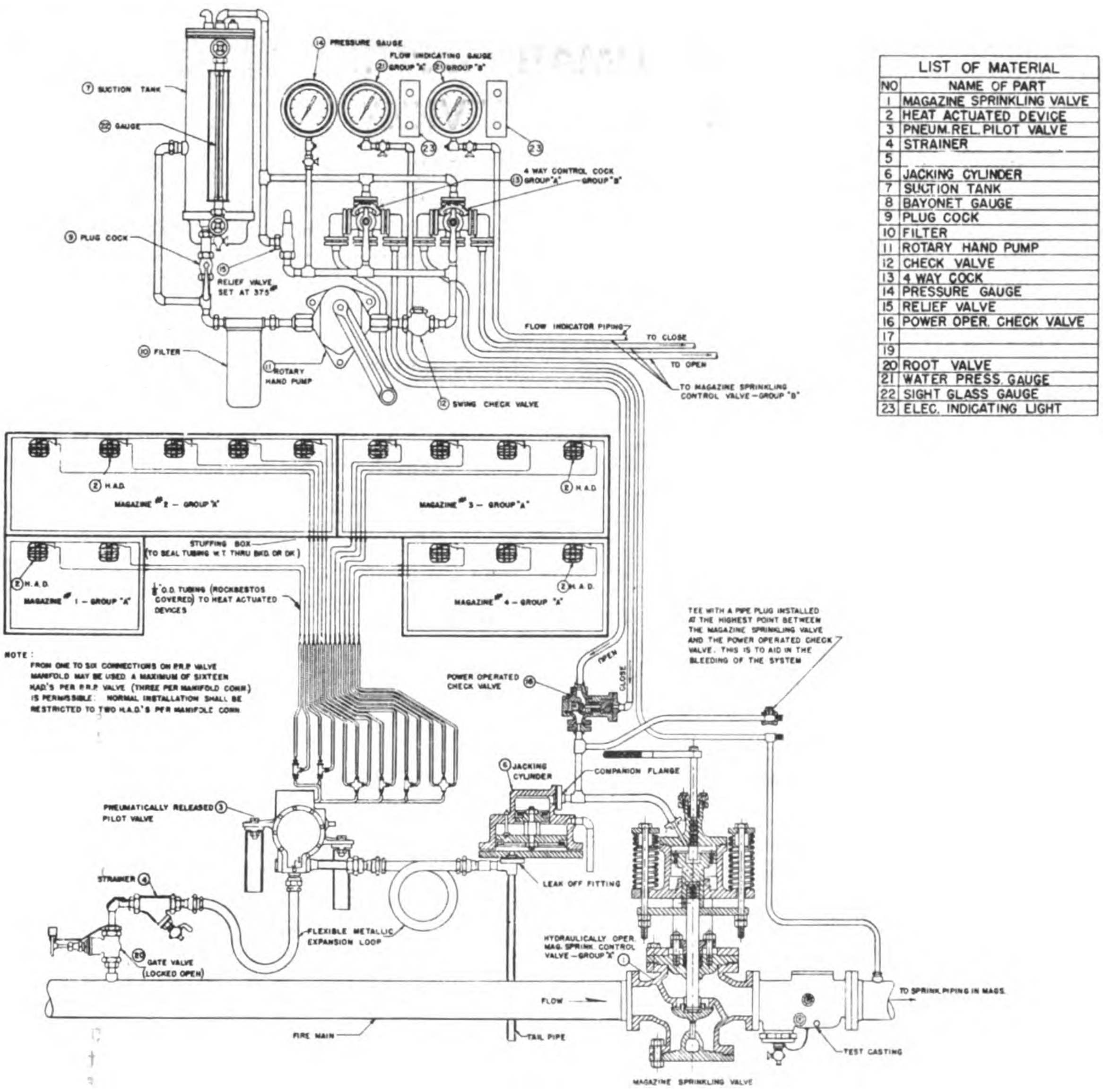
The earliest application of automatic control for sprinkling systems (rate-of-rise) consists of the use of one or several heat actuated devices (HAD), installed in the magazine or ammunition stowage space. The HAD is connected by 1/8-inch insulated tubing to a pneumatically released pilot valve (PRP) which controls the operation of a jacking cylinder; the jacking cylinder, in turn, controls the operation of the sprinkling system main control valve. (The rate-of-rise device and associated hydraulic system are shown in the illustration on facing page.)

The design of the rate-of-rise (primary) system for the automatic control device is based on the following principles:

1. Air expands when heated.
2. Expansion of the air in a closed container produces pressure.
3. Pressure can be converted to mechanical energy.

The rate-of-rise device is designed to open the magazine main (group) control valve when the device absorbs heat from fire in or near the protected compartment, to create within the automatic control device a definite volume of pressure in a certain time. On naval vessels, the device functions when the internal pressure is equivalent to the pressure produced by 6 to 10 inches of water within 10 seconds after the HAD has been exposed to external heat.

When the heat is absorbed by the device at a slower rate than the one mentioned in the preceding paragraph, the system does not function, since provision is made within the pneumatic release pilot valve (PRP) to allow for normal temperature changes within the compartment.


⑭ PRESSURE GAUGE
FLOW INDICATING GAUGE
㉑ GROUP "A" ㉑ GROUP "B"
⑦ SUCTION TANK
㉒ GAUGE
㉓
㉓
4 WAY CONTROL COCK
⑬ GROUP "A" — GROUP "B"
⑨ PLUG COCK
⑮ RELIEF VALVE SET AT 375#
⑩ FILTER
⑪ ROTARY HAND PUMP
⑫ SWING CHECK VALVE
FLOW INDICATOR PIPING
TO CLOSE
TO OPEN
TO MAGAZINE SPRINKLING CONTROL VALVE—GROUP "B"
② H.A.D.
MAGAZINE #2 — GROUP "A"
② H.A.D.
MAGAZINE #3 — GROUP "A"
STUFFING BOX (TO SEAL TUBING W.T. THRU BKD. OR DK.)
② H.A.D.
MAGAZINE # 1 — GROUP "A"
1/8" O.D. TUBING (ROCKBESTOS COVERED) TO HEAT ACTUATED DEVICES
② H.A.D.
MAGAZINE # 4 — GROUP "A"
NOTE:
FROM ONE TO SIX CONNECTIONS ON P.R.P. VALVE MANIFOLD MAY BE USED. A MAXIMUM OF SIXTEEN H.A.D.'S PER P.R.P. VALVE (THREE PER MANIFOLD CONN.) IS PERMISSIBLE: NORMAL INSTALLATION SHALL BE RESTRICTED TO TWO H.A.D.'S PER MANIFOLD CONN.
TEE WITH A PIPE PLUG INSTALLED AT THE HIGHEST POINT BETWEEN THE MAGAZINE SPRINKLING VALVE AND THE POWER OPERATED CHECK VALVE. THIS IS TO AID IN THE BLEEDING OF THE SYSTEM
OPEN
CLOSE
POWER OPERATED CHECK VALVE ⑯
⑥ JACKING CYLINDER
COMPANION FLANGE
PNEUMATICALLY RELEASED ③ PILOT VALVE
STRAINER ④
⑳ GATE VALVE (LOCKED OPEN)
FLEXIBLE METALLIC EXPANSION LOOP
LEAK OFF FITTING
HYDRAULICALLY OPER. MAG. SPRINK. CONTROL VALVE—GROUP "A" ①
FLOW
TO SPRINK. PIPING IN MAGS.
FIRE MAIN
TAIL PIPE
TEST CASTING
MAGAZINE SPRINKLING VALVE

LIST OF MATERIAL	
NO	NAME OF PART
1	MAGAZINE SPRINKLING VALVE
2	HEAT ACTUATED DEVICE
3	PNEUM. REL. PILOT VALVE
4	STRAINER
5	
6	JACKING CYLINDER
7	SUCTION TANK
8	BAYONET GAUGE
9	PLUG COCK
10	FILTER
11	ROTARY HAND PUMP
12	CHECK VALVE
13	4 WAY COCK
14	PRESSURE GAUGE
15	RELIEF VALVE
16	POWER OPER. CHECK VALVE
17	
19	
20	ROOT VALVE
21	WATER PRESS. GAUGE
22	SIGHT GLASS GAUGE
23	ELEC. INDICATING LIGHT

202. HYDRAULIC AND AUTOMATIC THERMO-PNEUMATIC RATE-OF-RISE CONTROL SYSTEMS FOR OPERATING MAGAZINE SPRINKLING CONTROL VALVES

A gate valve and strainer are installed in the salt water line between the fire main and PRP valve. (Refer to the illustration above.) The gate valve is locked open, except during servicing of the sprinkling system. The strainer is of a special wye type, with fine perforations (slots) in a Monel basket. A drain cock is provided in the strainer body to drain the sediment accumulated from the fire main water supplied to the PRP valve.

The jacking cylinder connects the oil in the hydraulic system for operating the main control valve and the water from the fire main which is the activating medium for the automatic control device. (Refer to the illustration above and the illustration on the following page.) The oil side (small diameter) and water side (large diameter) of the cylinder contain, respectively, a piston with hydraulic cup packings suitable for oil service and another piston with packings suitable for salt water service. Both pistons are interconnected in tandem.

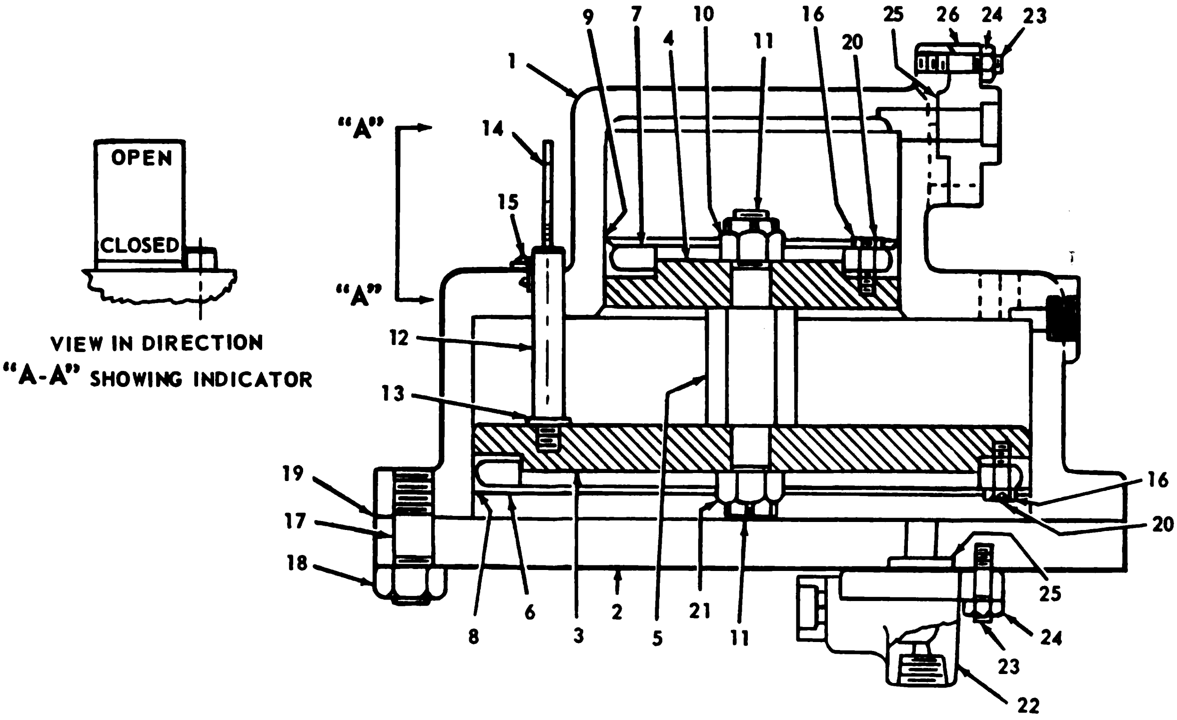
The water side of the cylinder is designed so that when a maximum water pressure of 40 psi is applied to the water piston, sufficient pressure is transmitted by the oil piston to overcome the spring force and water pressure acting on the valve disk of the sprinkling system main control valve.

The jacking cylinder is equipped with an indicator which provides visual indication of the piston positions. A vent installed between the pistons in the body of the jacking cylinder provides draining when a leakage past either piston occurs.

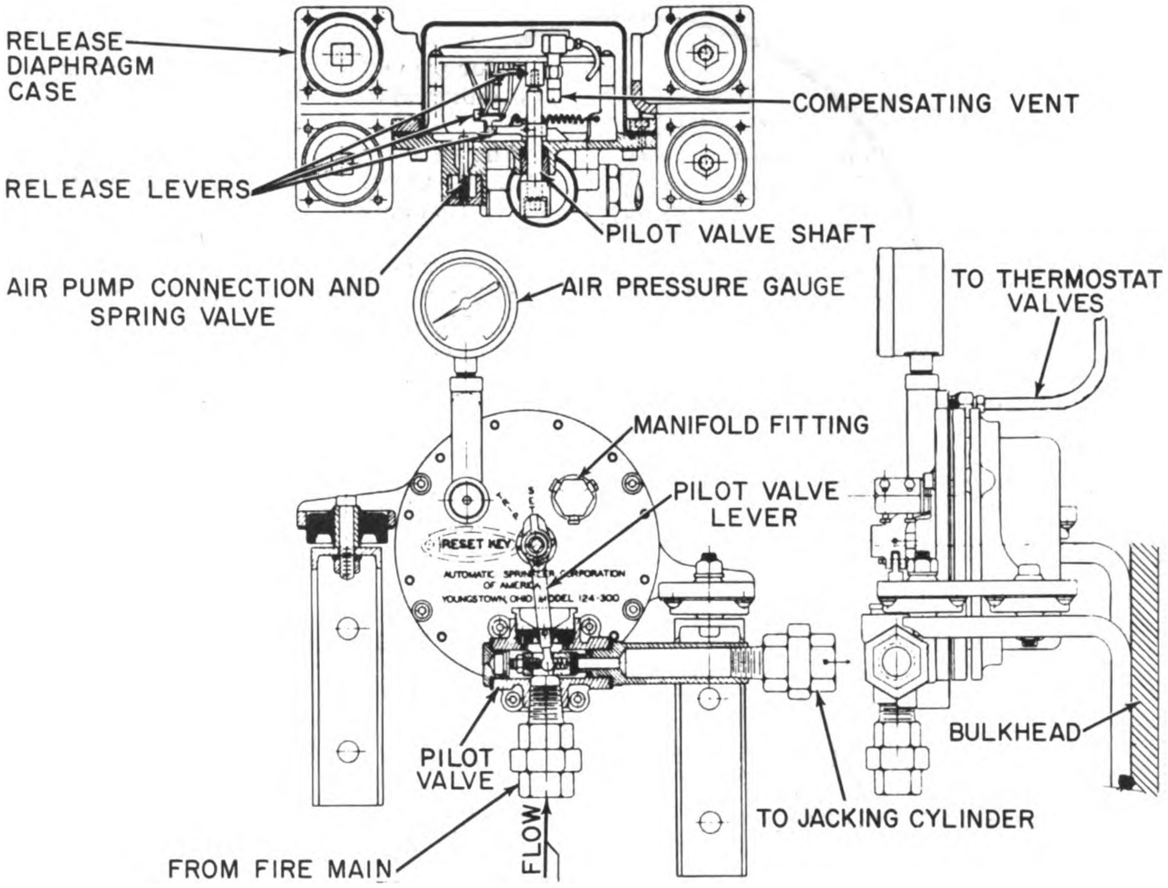
The early model jacking cylinder contains a leak off fitting and a tail pipe (refer to the illustration on preceding page) which are installed on the water side of the jacking cylinder to permit release of water during resetting of the pneumatically released pilot valve (PRP) after the automatic control device has been actuated. A small hole in the leak off fitting would prevent the jacking cylinder from lifting if a leak should develop

LIST OF MATERIAL	
NO.	NAME OF PART
1	CYLINDER
2	COVER
3	LOWER PISTON
4	UPPER PISTON
5	POST
6	LOWER RETAINING RING
7	UPPER RETAINING RING
8	LOWER PISTON CUP
9	UPPER PISTON CUP
10	HEX CASTLE NUT
11	COTTER PIN
12	INDICATOR ROD
13	LOCK WASHER

LIST OF MATERIAL	
NO.	NAME OF PART
14	INDICATOR PLATE
15	ROUND HEAD MACHINE SCREW
16	HEX HEAD MACHINE SCREW
17	STUD
18	HEX NUT
19	GASKET
20	LOCKING WIRE
21	HEX CASTLE NUT
22	LEAKOFF FITTING
23	STUD
24	HEX NUT
25	GASKET
26	COMPANION FLANGE



203. JACKING CYLINDER



204. THREE VIEWS OF THE PNEUMATICALLY RELEASED PILOT VALVE (PRP)

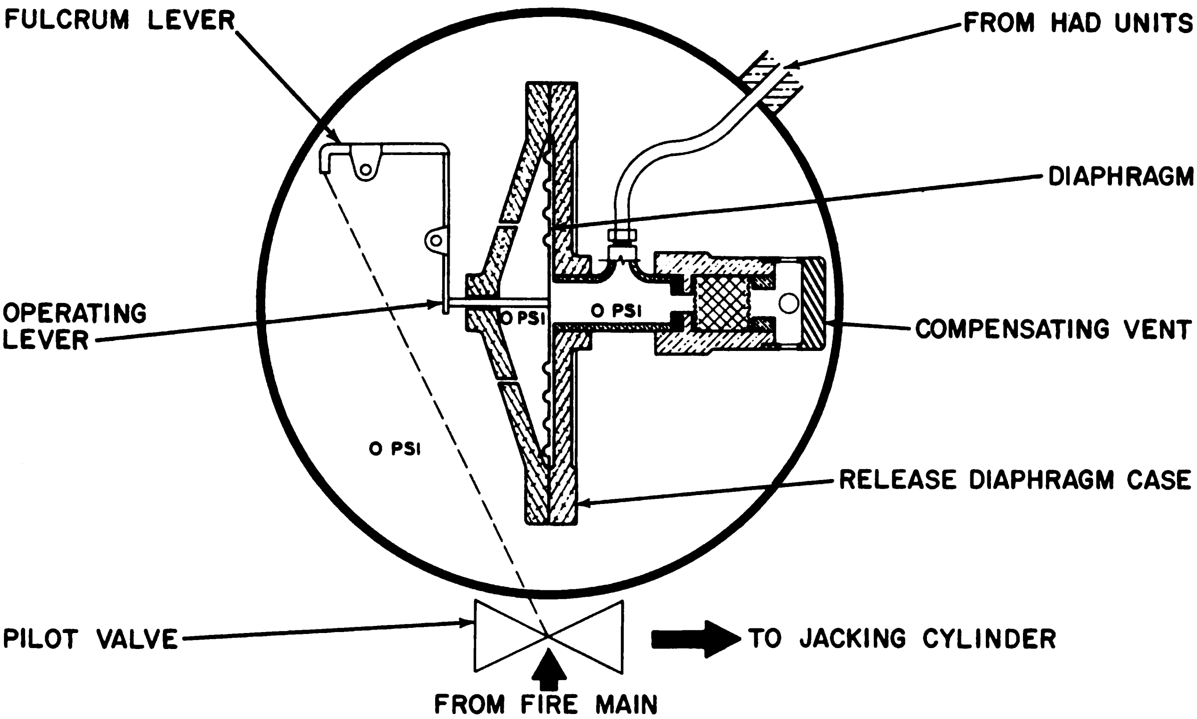
in the PRP valve. (The PRP valve is shown in three views in the illustration above and is also shown schematically in the illustration on the following page.)

The PRP valve releases water from the fire main to the large area side of the jacking cylinder when the temperature rate-of-rise in the compartment protected exceeds a preset level.

The PRP valve assembly consists of a bronze case which encloses a release diaphragm, chamber, linkage, springs, and a pilot valve shaft and levers. The shaft and levers are connected to the PRP which opens and closes to control fire main input to the jacking cylinder. The shaft and levers are arranged so that any sudden pressure increase causes the diaphragm to extend into the diaphragm chamber and to trip the operating lever out from under the fulcrum lever. When the fulcrum lever is released, the pilot valve is opened by spring action.

Slow changes in pressure from the HAD are equalized by the compensating vent which is installed in the PRP case. (Refer to the illustration on the following page.) This vent consists of a carefully calibrated leak in a special stainless steel fitting. (An enlarged view of the compensating vent is presented in the illustration at the bottom of following page.)

The heat actuated device (HAD) is a pneumatic thermostat which consists of a hollow brass chamber whose capacity is about 14 cubic inches. The HAD is located in the protected compartment and creates the pressure necessary to actuate the PRP valve when the rate-of-rise of the temperature in the protected compartment becomes excessive.



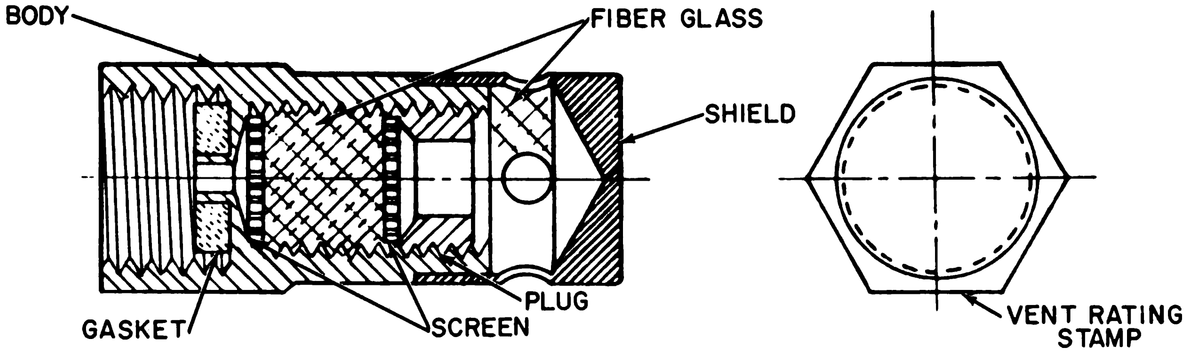
205. PNEUMATICALLY RELEASED PILOT VALVE (PRP), SCHEMATIC

(Refer to the center illustration on facing page.) The excessive heat is absorbed by the HAD and is utilized to heat the air trapped in the system. The heated air expands and creates a pressure which is transmitted through 1/8-inch tubing to the PRP diaphragm.

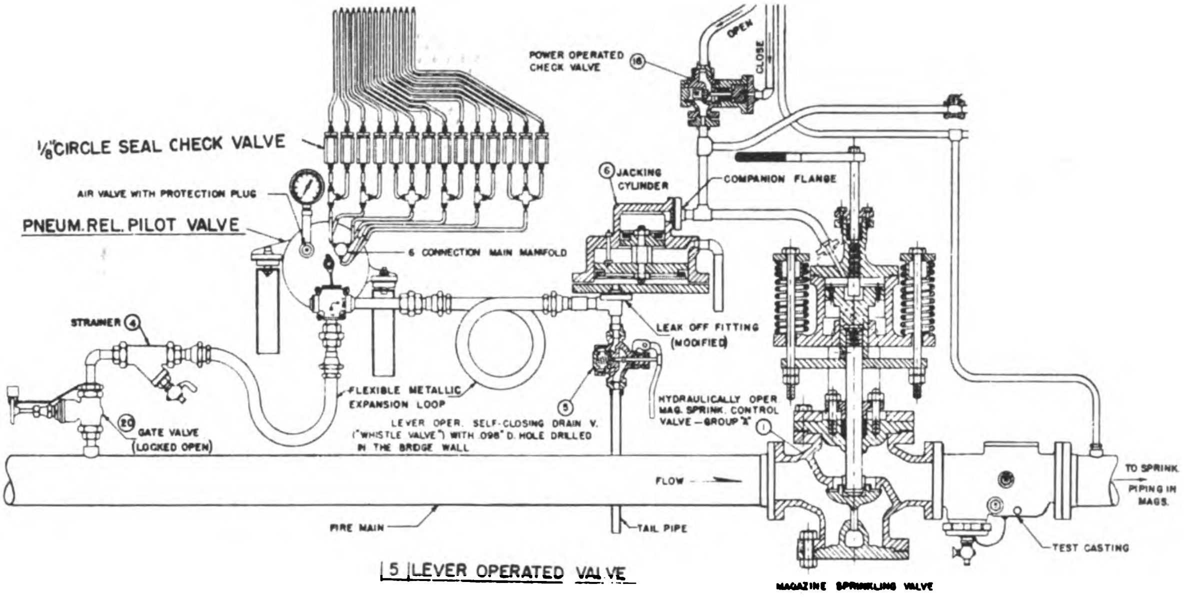
One or more HAD's are installed on the overhead of each compartment protected. The HAD's are encased in wire guards.

A modified late model of a rate-of-rise automatic control device (shown in the illustration at top of facing page) includes the following improvements:

1. A minimum of two HAD's in each compartment protected.
2. A modified design PRP valve.
3. A circle seal check valve in each transmission line between the PRP valve and the HAD.



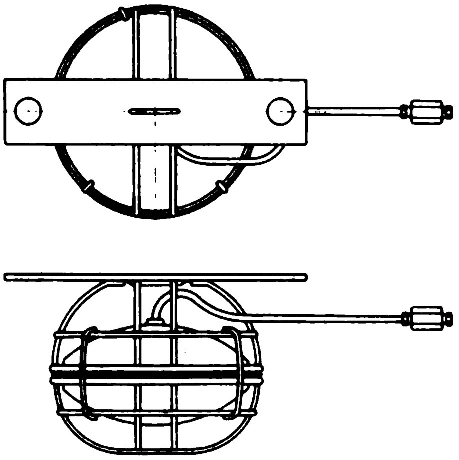
206. COMPENSATING VENT


1/8" CIRCLE SEAL CHECK VALVE
AIR VALVE WITH PROTECTION PLUG
PNEUM. REL. PILOT VALVE
6 CONNECTION MAIN MANIFOLD
STRAINER ④
⑳ GATE VALVE (LOCKED OPEN)
FLEXIBLE METALLIC EXPANSION LOOP
⑤
LEVER OPER. SELF-CLOSING DRAIN V. ("WHISTLE VALVE") WITH .098" D. HOLE DRILLED IN THE BRDGE WALL
FIRE MAIN
15 LEVER OPERATED VALVE
POWER OPERATED CHECK VALVE ⑯
OPEN
CLOSE
⑥ JACKING CYLINDER
COMPANION FLANGE
LEAK OFF FITTING (MODIFIED)
HYDRAULICALLY OPER MAG. SPRINK. CONTROL VALVE — GROUP "A" ①
FLOW
TAIL PIPE
TO SPRINK. PIPING IN MAGS.
TEST CASTING
MAGAZINE SPRINKLING VALVE

207. MODIFIED RATE-OF-RISE AUTOMATIC CONTROL DEVICE

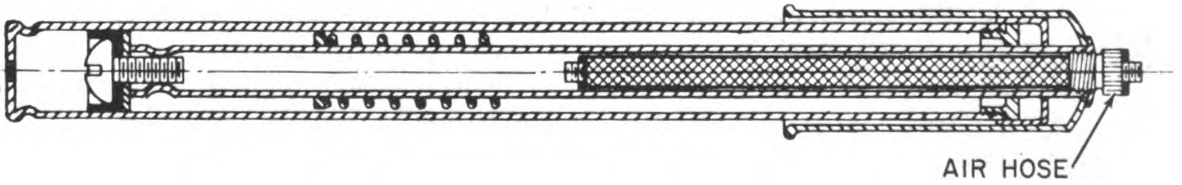
4. A lever operated drain valve in the salt water side of the jacking cylinder.

The PRP valve has been modified to include an air gauge, an air charging valve, and a reset key. The air gauge and charging valve are installed to provide a means of pressurizing the automatic control device, to test for leaks. The air pump is provided with the special tools for use in the pressure test. (Refer to the illustration below.) The reset key is provided for resetting of the PRP valve operating mechanism after the valve has been tripped. (Refer to the illustration on page 335.)

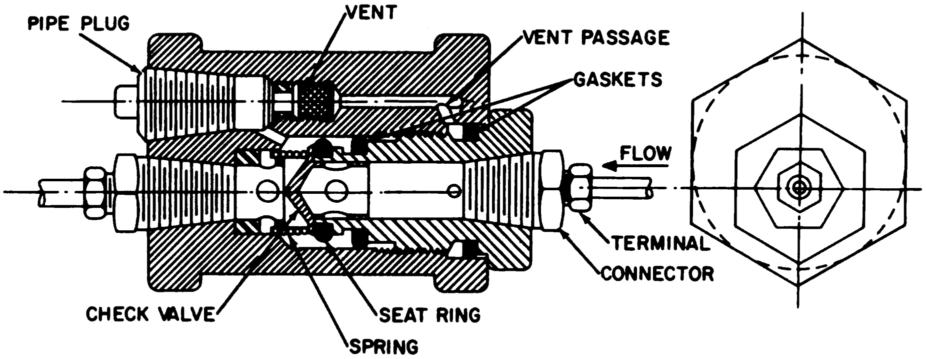


208. HEAT ACTUATED DEVICE (HAD)

The circle seal check valve is spring loaded and is designed to check against sudden changes of pressure in one direction and to open when pressure is applied from the opposite direction. The valve housing contains a restricted bypass orifice which is used to equalize pressure in the system. Circle seal check valves are installed in the air tubing of each HAD, so that pressure



209. PNEUMATIC PUMP



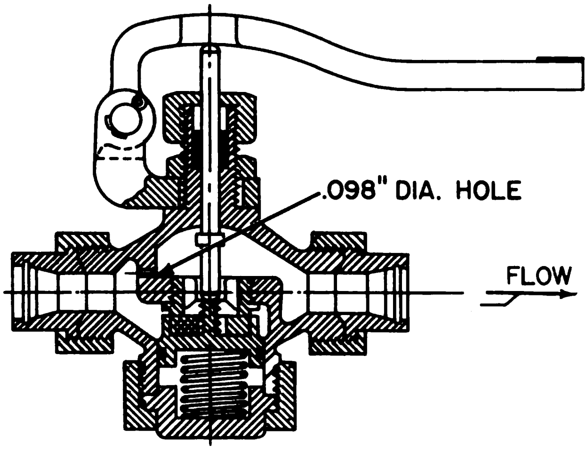
210. CIRCLE SEAL CHECK VALVE

created in one HAD is restricted to the diaphragm chamber of the PRP valve assembly instead of pressurizing the entire system. (The direction of air flow is shown in the illustration above.)

A lever operated drain valve is installed in the sale water side of the jacking cylinder. This valve is selfclosing. When opened, it drains the water side of the jacking cylinder.

After the PRP valve has been reset, the lever operated drain valve must be manually opened before the jacking cylinder returns to its normal position and allows the sprinkling system main control valve to close.

A .098-inch hole, located in the bridge wall of the lever operated drain valve, prevents premature sprinkling of a magazine by salt water leaking from the PRP valve. (A cutaway view of the lever operated drain valve is provided in the illustration below.)



211. LEVER OPERATED DRAIN VALVE

The latest model of an automatic control device incorporates the following features (refer to the illustration on facing page):

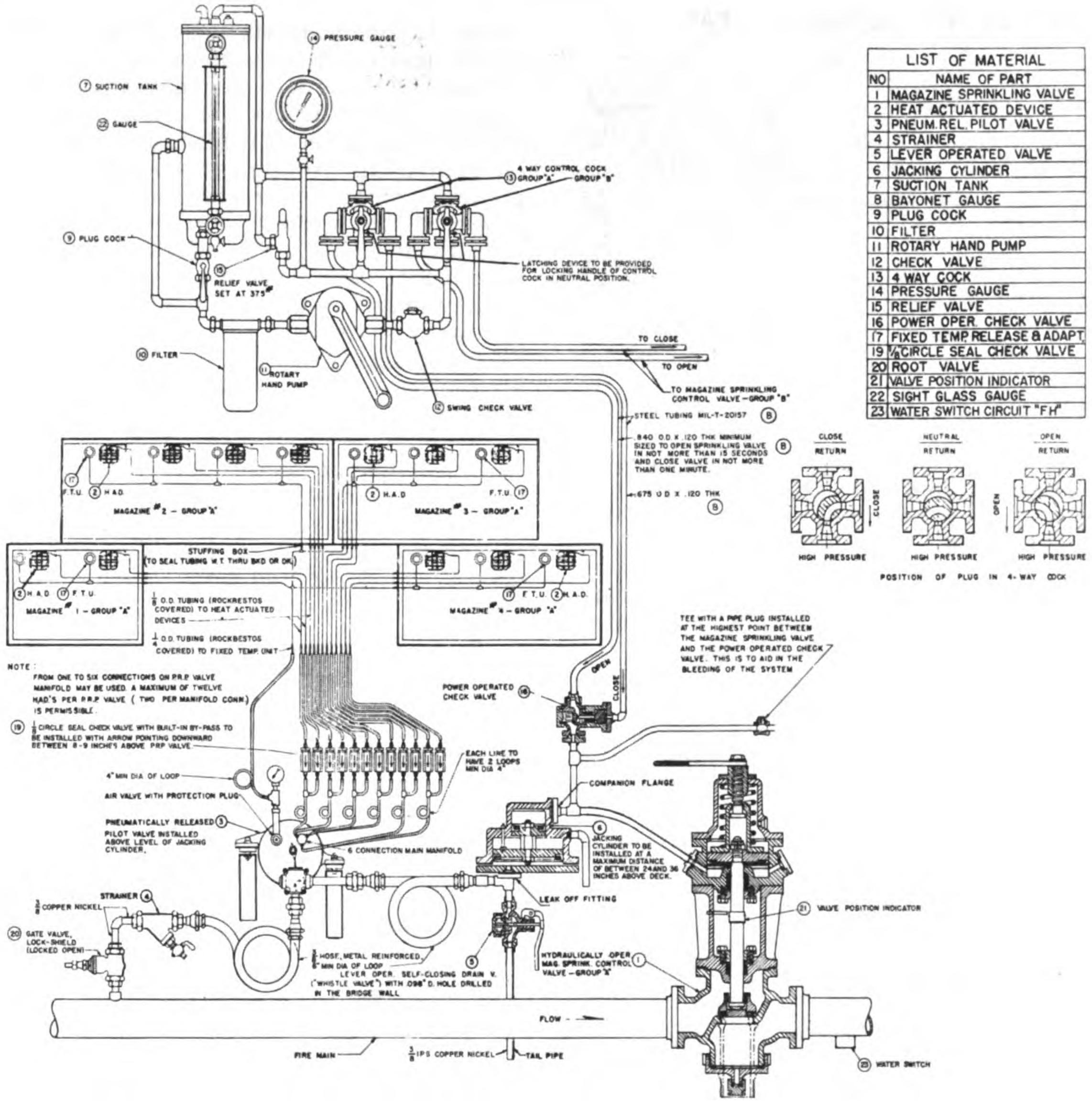
1. A fixed temperature unit (FTU) for each HAD in the protected compartment.
2. Additional expansion loops in the tubing from the HAD's.
3. A water switch in the dry side of the sprinkling system main control valve.
4. The new type sprinkling system main control valve.

The design of the fixed temperature (secondary) system used with the automatic control device is based on the same principles as the design of the rate-of-rise system, plus the following:

1. Pressure can be converted to mechanical energy.
2. Heat can be converted to mechanical energy.

The fixed temperature units (FTU's) are designed to actuate the automatic control device when the temperature reaches a predetermined value (150° F. in some sprinkling systems).

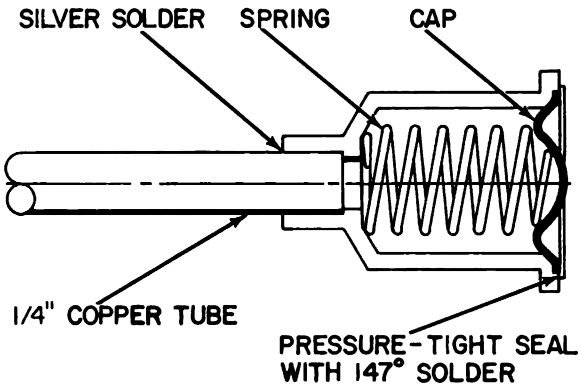
NOTE: The temperature rise must be slow, otherwise the HAD unit will actuate the automatic control device before the FTU can function.



LIST OF MATERIAL	
NO	NAME OF PART
1	MAGAZINE SPRINKLING VALVE
2	HEAT ACTUATED DEVICE
3	PNEUM. REL. PILOT VALVE
4	STRAINER
5	LEVER OPERATED VALVE
6	JACKING CYLINDER
7	SUCTION TANK
8	BAYONET GAUGE
9	PLUG COCK
10	FILTER
11	ROTARY HAND PUMP
12	CHECK VALVE
13	4 WAY COCK
14	PRESSURE GAUGE
15	RELIEF VALVE
16	POWER OPER. CHECK VALVE
17	FIXED TEMP. RELEASE & ADAPT.
19	1/8" CIRCLE SEAL CHECK VALVE
20	ROOT VALVE
21	VALVE POSITION INDICATOR
22	SIGHT GLASS GAUGE
23	WATER SWITCH CIRCUIT "FH"

⑭ PRESSURE GAUGE
⑦ SUCTION TANK
㉒ GAUGE
4 WAY CONTROL COCK
⑬ GROUP "A" GROUP "B"
⑨ PLUG COCK
⑮ RELIEF VALVE SET AT 375#
LATCHING DEVICE TO BE PROVIDED FOR LOCKING HANDLE OF CONTROL COCK IN NEUTRAL POSITION.
⑩ FILTER
⑪ ROTARY HAND PUMP
⑫ SWING CHECK VALVE
TO CLOSE
TO OPEN
TO MAGAZINE SPRINKLING CONTROL VALVE—GROUP "B"
STEEL TUBING MIL-T-20157 Ⓑ
.840 O.D. X .120 THK MINIMUM SIZED TO OPEN SPRINKLING VALVE IN NOT MORE THAN 15 SECONDS AND CLOSE VALVE IN NOT MORE THAN ONE MINUTE. Ⓑ
.675 O.D. X .120 THK Ⓑ
CLOSE
RETURN
CLOSE
HIGH PRESSURE
NEUTRAL
RETURN
HIGH PRESSURE
OPEN
RETURN
OPEN
HIGH PRESSURE
POSITION OF PLUG IN 4-WAY COCK
⑰ F.T.U. ② H.A.D.
MAGAZINE #2 — GROUP "A"
② H.A.D. F.T.U. ⑰
MAGAZINE #3 — GROUP "A"
STUFFING BOX (TO SEAL TUBING W.T. THRU BKD OR DK.)
② H.A.D. ⑰ F.T.U.
MAGAZINE # 1 — GROUP "A"
1/8 O.D. TUBING (ROCKBESTOS COVERED) TO HEAT ACTUATED DEVICES
1/4 O.D. TUBING (ROCKBESTOS COVERED) TO FIXED TEMP. UNIT
⑰ F.T.U. ② H.A.D.
MAGAZINE # 4 — GROUP "A"
NOTE:
FROM ONE TO SIX CONNECTIONS ON P.R.P. VALVE MANIFOLD MAY BE USED. A MAXIMUM OF TWELVE HAD'S PER P.R.P. VALVE (TWO PER MANIFOLD CONN.) IS PERMISSIBLE.
⑲ 1/8 CIRCLE SEAL CHECK VALVE WITH BUILT-IN BY-PASS TO BE INSTALLED WITH ARROW POINTING DOWNWARD BETWEEN 8-9 INCHES ABOVE PRP VALVE.
TEE WITH A PIPE PLUG INSTALLED AT THE HIGHEST POINT BETWEEN THE MAGAZINE SPRINKLING VALVE AND THE POWER OPERATED CHECK VALVE. THIS IS TO AID IN THE BLEEDING OF THE SYSTEM
POWER OPERATED CHECK VALVE ⑯
OPEN
CLOSE
EACH LINE TO HAVE 2 LOOPS MIN DIA 4"
4" MIN DIA OF LOOP
AIR VALVE WITH PROTECTION PLUG
PNEUMATICALLY RELEASED ③ PILOT VALVE INSTALLED ABOVE LEVEL OF JACKING CYLINDER.
6 CONNECTION MAIN MANIFOLD
COMPANION FLANGE
⑥ JACKING CYLINDER TO BE INSTALLED AT A MAXIMUM DISTANCE OF BETWEEN 24 AND 36 INCHES ABOVE DECK.
LEAK OFF FITTING
㉑ VALVE POSITION INDICATOR
STRAINER ④
3/8 COPPER NICKEL
⑳ GATE VALVE, LOCK-SHIELD (LOCKED OPEN)
3/8 HOSE, METAL REINFORCED, 6" MIN DIA OF LOOP
⑤ LEVER OPER. SELF-CLOSING DRAIN V. ("WHISTLE VALVE") WITH .098" D. HOLE DRILLED IN THE BRIDGE WALL
HYDRAULICALLY OPER. MAG. SPRINK. CONTROL VALVE — GROUP "A" ①
FLOW
FIRE MAIN
3/8 IPS COPPER NICKEL
TAIL PIPE
㉓ WATER SWITCH

212. HYDRAULIC AND AUTOMATIC THERMO-PNEUMATIC RATE-OF-RISE AND FIXED TEMPERATURE CONTROL SYSTEMS FOR OPERATING MAGAZINE SPRINKLING CONTROL VALVES



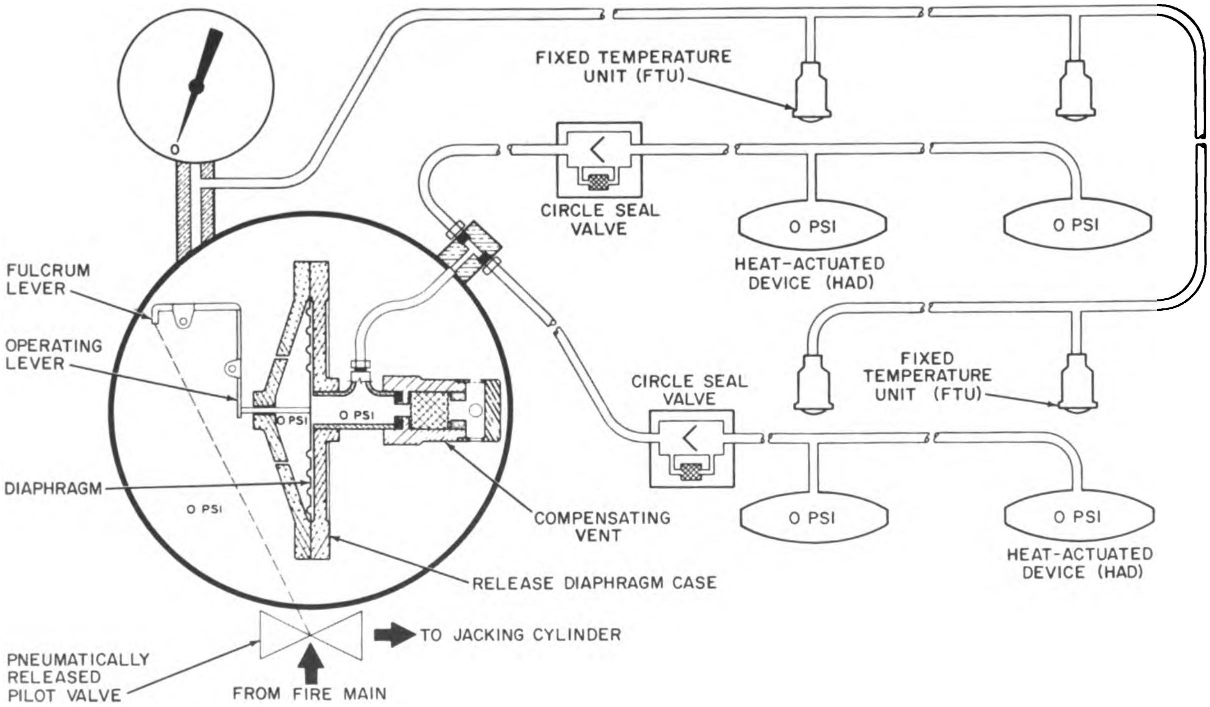
213. FIXED TEMPERATURE UNIT (FTU)

An FTU consists of a spring loaded cap which is held in place by indium solder. (Refer to the illustration above.) This solder is made of such material that it melts at the predetermined maximum setting for the protected compartment. When the FTU cap is freed, the pressure in the PRP valve case is released, causing the automatic control device to actuate.

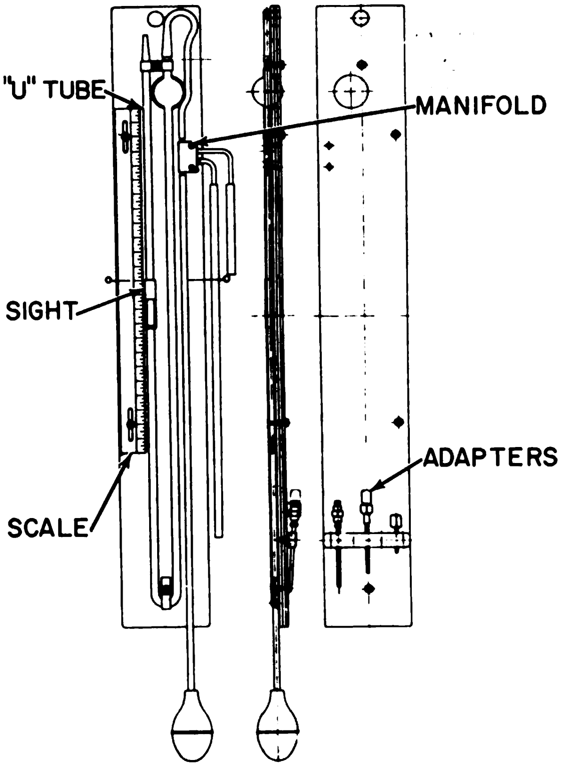
A schematic of the latest automatic control device is provided in the illustration below, to ease understanding of the operation of this device. It is assumed that the temperature in the protected compartment rises at a slow rate. As the temperature rises, the HAD's respond by transmitting the heat in the form of air pressure to the PRP diaphragm. Since the air-pressure rise is slow, it is equalized within the PRP diaphragm case by the compensating vent, thus preventing the PRP valve from being actuated. However, when the temperature in the protected compartment reaches the predetermined maximum level, the FTU opens and vents the air pressure built up in the diaphragm case, causing the PRP valve to trip.

The automatic control device is subjected to certain tests which must be performed before and during installation, at the completion of installation, and periodically thereafter as specified in the ship checkoff lists.

Tests performed during installation and at the completion of installation shall be accomplished by using a manometer. (Refer to the illustration on facing page.) The manometer is a U-shaped glass tube mounted



214. SPRINKLING SYSTEM AUTOMATIC CONTROL DEVICE, LATE MODEL, SCHEMATIC



215. MANOMETER

on a board, together with a scale, manifold, rubber tubing, and a rubber bulb. This meter is used to measure the pressure developed by the rate-of-rise system, the pressure required to operate the pneumatic release pilot valve, and the rate of operation of the compensating vent. (The manometer is not used for periodic tests onboard ship.)

The following periodic tests should be performed onboard ship in accordance with the requirements outlined in the checkoff lists.

WARNING

> Before starting the following tests, install the test fitting assembly in the sprinkling system main control valve (new type) or wedge the flapper valve or disk (old type) closed.

PERFORM THE FOLLOWING OPERATIONS:

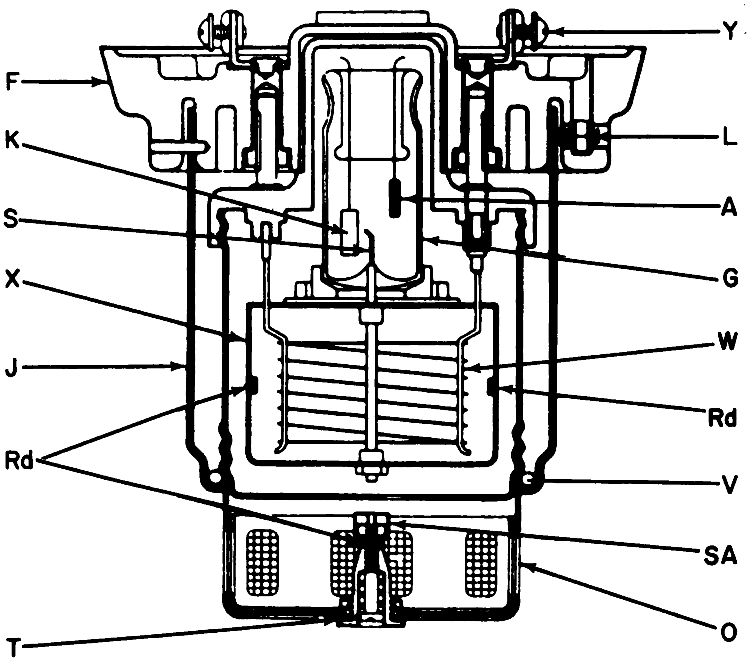
1. Perform test to determine airtightness of HAD and operability of FTU system.

   a. Remove air cap from face of the PRP valve bronze case and connect the hand pump (refer to the illustration at the bottom of page 337.) Slowly pressurize the system until a pressure of 16 ounces is indicated by the air gauge. The system may need additional pumping, due to the slow passage of air through the vents, before a pressure balance is obtained. (The larger the system, the more additional pumping is required.) Secure pump and check to insure that no pressure drop occurs for a minimum of 5 minutes. Close pressure gauge and vent air from it.
   b. Immediately following successful airtightness test (point a. above), open the air gauge quickly to test action of the FTU system. The sudden release of pressure in the PRP valve case and FTU lines should actuate the PRP valve.

   NOTE: The actuation of the PRP valve simulates the condition created when the sealing disk (cap) of the FTU is ejected as the indium solder melts due to excessive heat in the protected area.

2. Perform test to determine operability of HAD.

   a. With the PRP valve reset and the air vented from the system, totally immerse the most remotely located accessible HAD in a container of water. (Water temperature should be at least 200° F.) The PRP valve should trip in a maximum of 5 seconds. Check the pilot valve and sprinkling system main control valve to insure that they are open. To expedite the test, cool the HAD with cold water or ice, reset the PRP valve, and open the drain valve to the jacking cylinder. Check to insure that the sprinkling system main control valve is closed.



F- SOCKET BASE
K- CATHODE
S- STARTER ELECTRODE
X- INNER OR REFERENCE CHAMBER
J- LOCKING SHELL
Ra-RADIUM SOUCES
T- SENSITIVITY ADJUSTMENT SCREW
Y- TERMINAL SCREWS
L- LOCKING SET SCREW
A- ANODE
G- GAS DISCHARGE (COLD CATHODE) TUBE
W- INNER WIRE GRID ELECTRODE
V- O RING
SA- SENSITIVITY ADJUSTMENT CAP
O- OUTER OR DETECTING CHAMBER

216. DETECTOR HEAD, CROSS-SECTIONAL VIEW

> NOTE: After completing the test, remove the test fitting or wedge from the sprinkling system main control valve.

Several types of warning devices or systems are used onboard ships, and one of them is the alarm system activated by the water switch on the dry side of the sprinkling system main (group) control valves. The alarm indicates by sound or by a light when the main control valve is leaking.

Another type of alarm system used is actuated by heat. The alarm sounds when the temperature in an ammunition storage area rises to the danger point. Due to this warning, the temperature can be reduced before sprinkling becomes necessary.

A new alarm system now in use is the pry-a-larm. This system functions according to an entirely different principle: The trigger of the pry-a-larm detector is activated by minute particles of combustion.

> NOTE: Formation of combustion particles occurs in all types of fires and even in smoldering or overheated materials. The small combustion particles are invisible, but they are usually present before there is any other evidence of a fire; the larger particles are visible in the form of smoke. However, most of the particles are too small to be seen by the naked eye.

The advantages of a pry-a-larm system are as follows:

1. The early warning provided by the pry-a-larm system often permits safe evacuation of the endangered area and gives the damage control party time to fight the fire while the fire is still small and controllable.

2. The system may be adjusted (calibrated, to insure proper operation, regardless of its location onboard ship.

3. The electrical circuit associated with the pry-a-larm system is a standard two wire circuit. Because of the low current used, a thin walled conduit can be used.

4. Any failure of wiring or of other essential parts is immediately indicated on a trouble board located in the damage control central.

The most important part of the pry-a-larm warning system is the sensing element called the detector head. (Refer to illustration on facing page.) Basically, the detector head consists of two ionization chambers and a cold cathode tube.

TOPIC 4: MISSILE MAGAZINE CO_2 SMOTHERING SYSTEM

You Are Now Going to Learn:

1. The purpose of the missile magazine CO_2 system.
2. Components and theory of operation of the missile magazine CO_2 system.
3. Safety precautions applicable to the missile magazine CO_2 system.

Discussion Points for this Topic Are:

1. CO_2 system layout.
2. CO_2 system thermo-sylphon heat sensing device.
3. CO_2 system operation.
4. Safety precautions.
5. Review and summary.
6. Section review.
7. Written test on Sections 11 and 12.

INFORMATION AND DISCUSSION:

CO_2 (carbon dioxide) systems are installed in launcher carriages and magazine areas for controlling excessive heat and for fighting class B (oil) and C (electrical) fires. A sufficient number of cylinders containing liquid carbon dioxide (CO_2) are provided to flood the areas equipped with this system. (Illustration on the facing page shows a typical arrangement of a CO_2 system.)

Normally, the CO_2 system is operated pneumatically and is controlled by a thermo-sylphon heat sensing device; however, the system can also be manually activated by means of a local operating lever mounted on the control head(s) or can be remotely controlled by a cable and remotely operated handle mounted in a break-glass type pull box. (Illustration on page 346 is a schematic of the magazine CO_2 system.)

The operation of the CO_2 system is as follows:

The bellows of the thermo-sylphon heat sensing device are expanded and are held by the fusible link against the pressure of a compression spring.

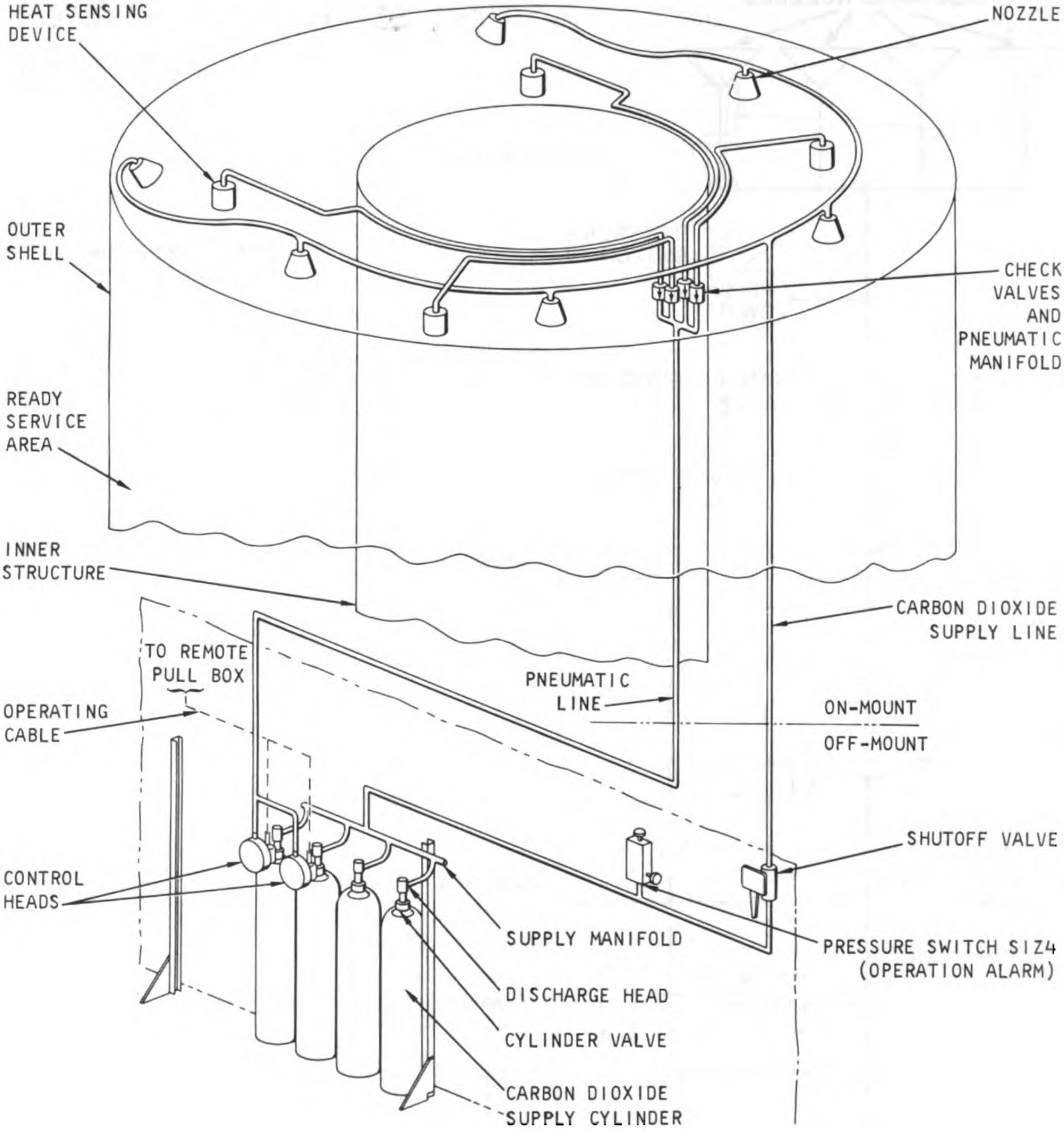
When a sudden temperature rise occurs in the magazine, the increased pressure cannot escape through the orifices which are located in the pressure chamber of the control heads. The resultant pressure buildup in the pressure chamber forces the diaphragm to expand. Also, excessive heat (158° Fahrenheit) in the area of a heat sensing device of any combination heat sensing device melts the fusible link(s).

> NOTE: Although the heat sensing devices discussed in this topic are set to activate at 158°F., other CO_2 systems may be set to activate at lower or higher temperatures than the one discussed in this topic.

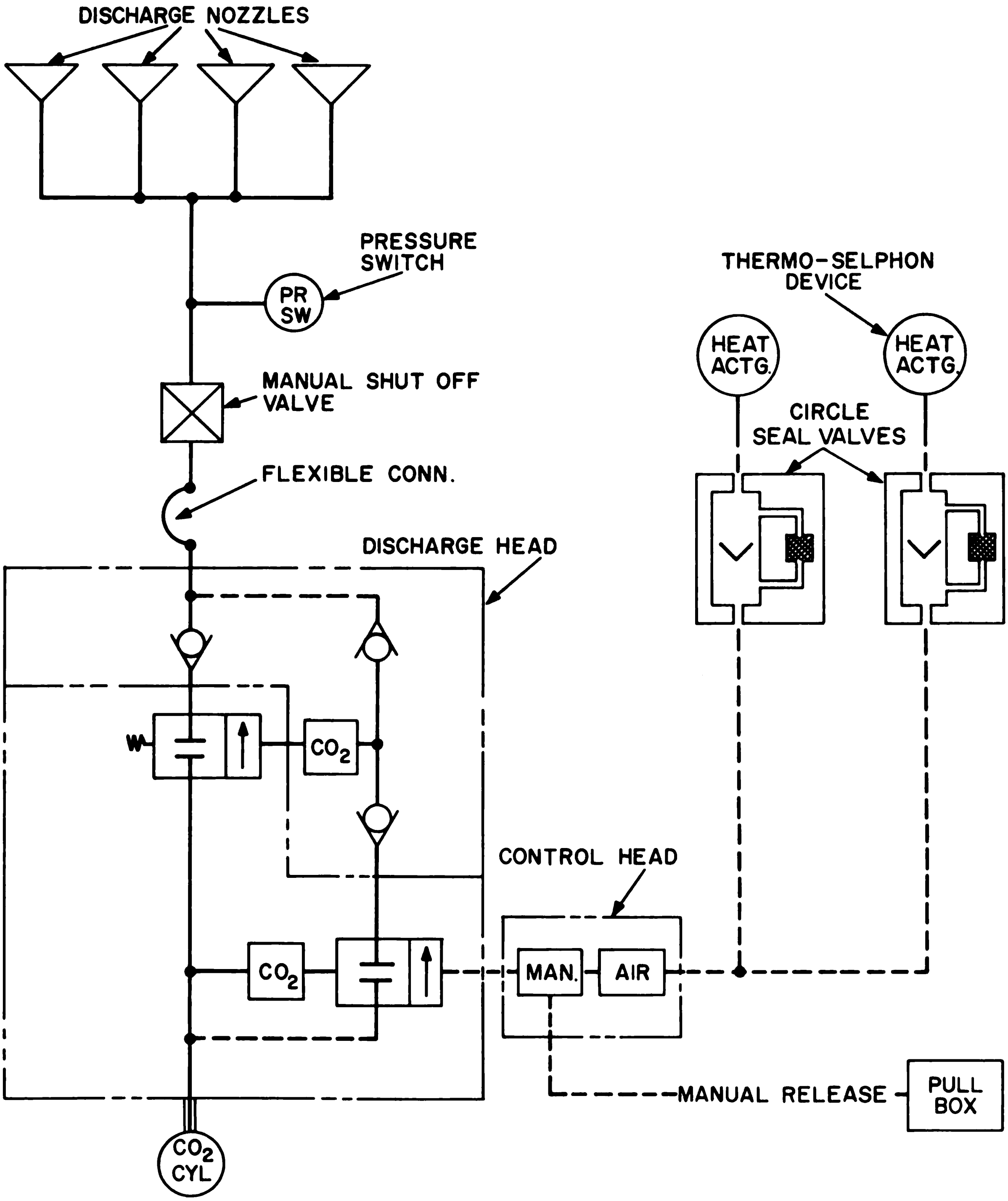
When the fusible link melts, it releases the compression spring, causing the bellows to collapse. As the bellows collapse, they produce a sudden pressure and cause a subsequent expansion of the diaphragm in the control head. (The thermo-sylphon heat sensing device is shown in illustration on page 347.)

Circle seal check valves are installed between the heat sensing devices and control heads. (Refer to illustration on page 347.) These check valves allow only a certain amount of pressure to pass in one direction and control sudden changes in pressure. The valves open when pressure is applied from the opposite direction.

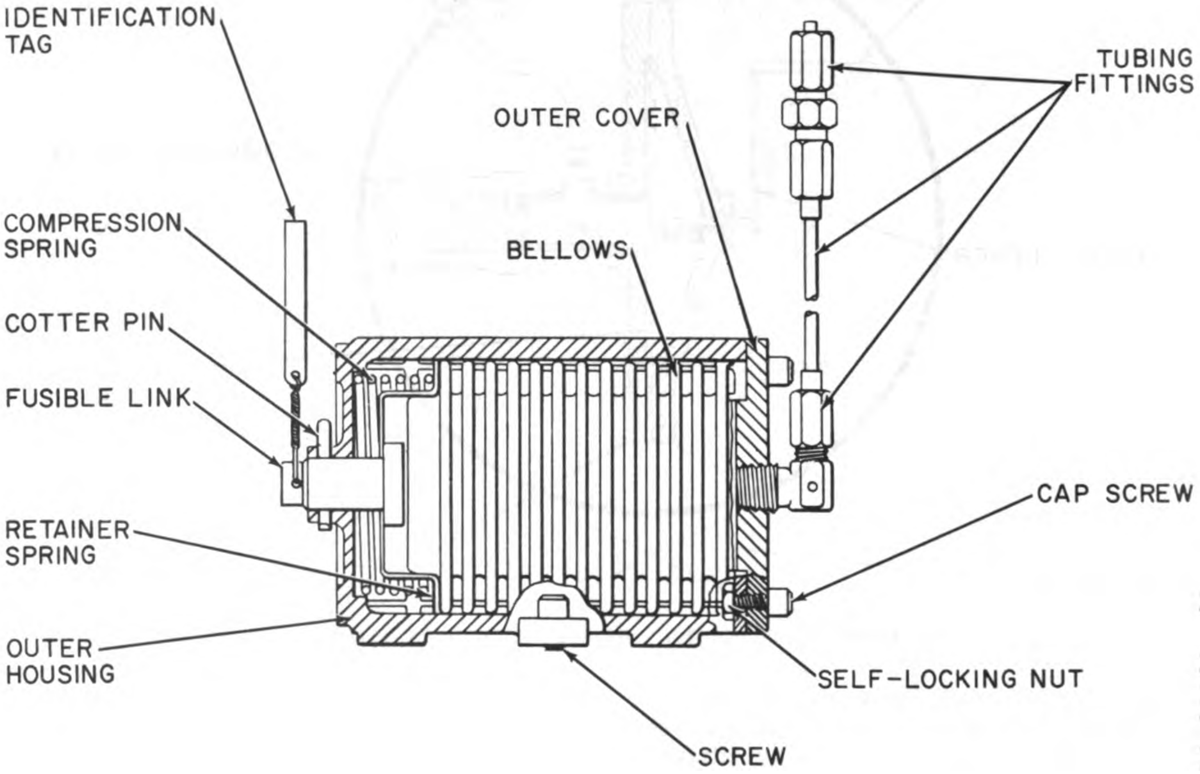
A check valve contains a restricted bypass orifice, to equalize pressure when minor temperature changes occur. The check valve confines the pressure created in a heat sensing device to the diaphragm of



217. CO_2 SYSTEM, TYPICAL ARRANGEMENT



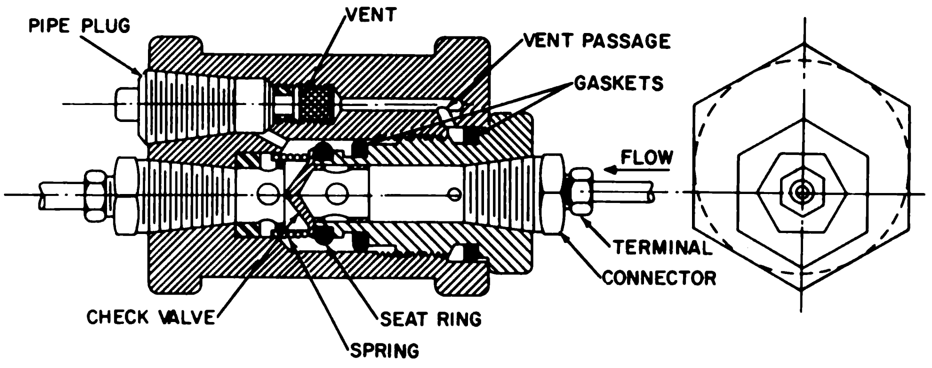
218. MAGAZINE CO_2 SYSTEM, SCHEMATIC



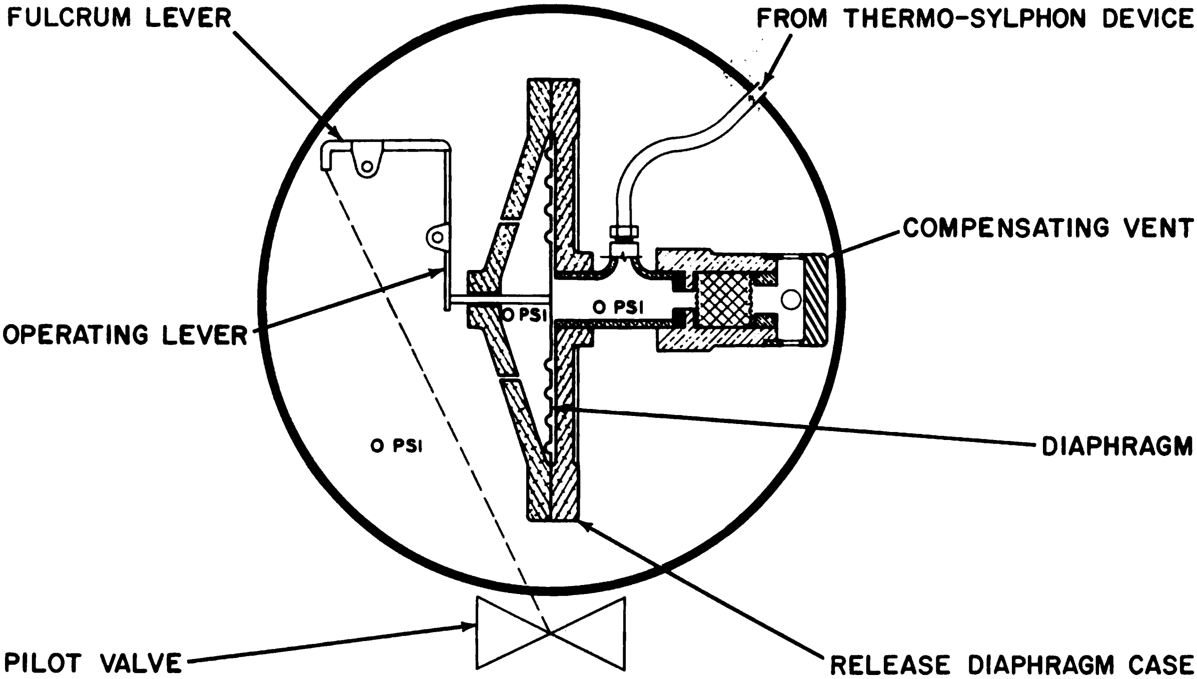
219. THERMO-SYLPHON HEAT SENSING DEVICE

the control head, thus preventing the entire system from being pressurized.

The control head consists of a diaphragm, pressure chamber, compensating vent, and a trigger mechanism. When the air pressure in the pressure chamber builds up faster than it can be vented, the diaphragm is forced to expand. As the diaphragm expands, it trips a lever that releases a trigger mechanism. The trigger, in turn, releases a spring loaded plunger which actuates a pilot valve in the discharge head.



220. CO$_2$ SYSTEM CIRCLE SEAL CHECK VALVE



221. CO_2 SYSTEM CONTROL HEAD, GENERAL ARRANGEMENT

The control heads are equipped with manually operated levers used for local control. These levers are secured by safety locking pins. The pins must be pulled out (seals must be broken) before the levers can be rotated.

The tube leading to the top of each control head contains the operating cable which is attached to the trigger mechanism. The trigger mechanism can also be released by pulling the remote operating handle.

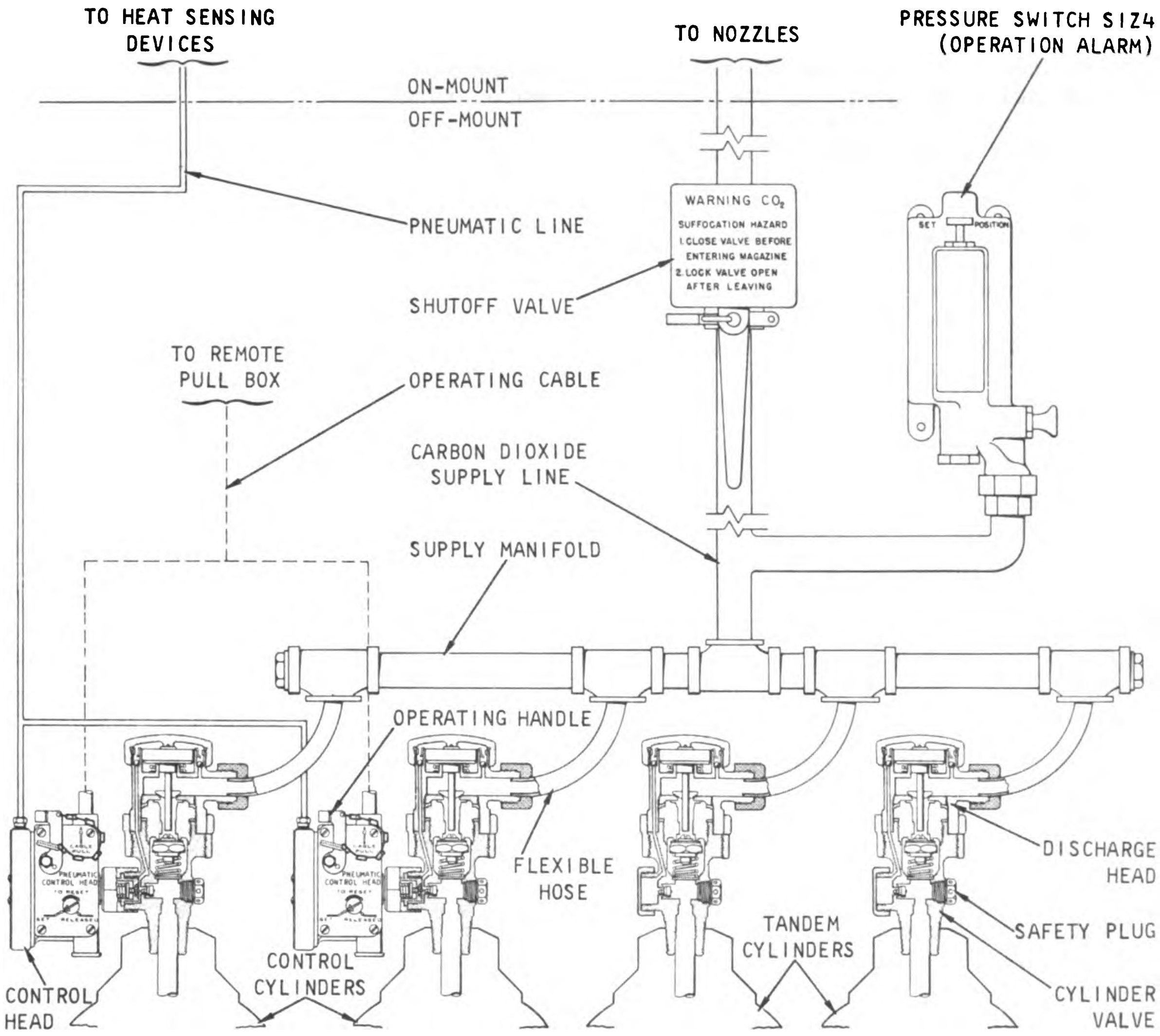
Reset shafts indicate whether the control heads are set or released. To reset the control heads, a large screwdriver must be used, to turn each reset dial clockwise to the SET position. (Illustration above shows the components and general arrangement of a CO_2 system control head.)

The combined cylinder valve/discharge head consists of a pilot valve, piston, control cylinder valve, three check valves, and a safety plug. (Illustration on facing page shows the general arrangement of the control heads and discharge heads.)

The pilot valve is actuated by the control head. When the pilot valve opens, liquid carbon dioxide flows through the pilot ports to the upper chambers of the discharge heads. The carbon dioxide is trapped by ball check valves, to ensure rapid and complete discharge of the cylinders. Pressure in the upper chamber of the discharge head forces the piston down, thereby opening the cylinder valve. The liquid carbon dioxide is then released into the supply manifold. From there, the carbon dioxide flows through the supply line to the discharge nozzles.

The discharge nozzles from the manifold of the supply cylinders are connected to the CO_2 supply line. An orifice in each nozzle restricts the discharge of CO_2, and the shield of the nozzle reduces the expansion velocity of the CO_2 so that the magazine is evenly blanketed.

Discharge nozzles are directed toward major electrical and hydraulic units, such as electric motors, slip rings, connection boxes, and hydraulic accumulators.



222. CONTROL HEADS AND DISCHARGE HEADS, GENERAL ARRANGEMENT

A manual shutoff valve is located downstream of the discharge head. This valve is normally locked in the OPEN position. The shutoff valve must be closed before personnel enters the magazine, to prevent suffocation hazards. Personnel leaving the magazine must lock the shutoff valve in the OPEN position, to restore proper operation of the CO_2 system.

A pressure operated switch is located between the manual shutoff valve and the discharge nozzles. When the CO_2 is activated, this switch closes and completes a circuit to an alarm system. (The general location of the pressure switch in this system is shown in illustrations on page 347 and above.)

The pressure switch can also be manually operated by pulling out the side button and then pulling up the top button. The switch is reset by pushing the top button in.

WARNING

Carbon dioxide is a dangerous asphyxiant, because even when it is present in hazardous quantities, it cannot be detected either by odor or color.

Do not enter an area or compartment containing hazardous amounts of carbon dioxide, without being equipped with an oxygen generating respirator.

Carbon dioxide is heavier than air and gives little (if any) warning to personnel exposed to it until they are completely overcome by it. The inhalation of carbon dioxide can produce various dangerous effects, depending on the length of time a person has been inhaling it.

The treatment of exposed personnel consists of artificial resuscitation, administration of oxygen, and of keeping the patient warm and quiet.

Warning devices, such as bells and red lights, are mounted outside the magazine or inside the magazine door, to forewarn personnel of CO_2 hazards.

WARNING

Before entering magazines for routine test, inspections, or maintenance, deactive the CO_2 system by closing the manual shutoff valve. When you leave the magazine, lock the valve in OPEN position.

QUIZ SHEET:

1. The sprinkling system control valves (described in Topic 1 of this section) are held closed by one of the following pressures:

   a. Hydraulic.
   b. Fire main.
   c. Spring.
   d. Fire main and spring.

2. The sprinkling system control valves (described in Topic 1 of this section) are closed by hydraulic pressure acting against a piston.

   True__________or False____________.

3. The missile magazine sprinkling system main control valve (described in Topic 2 of this section) is opened by one of the following pressures:

   a. Hydraulic.
   b. Fire main.
   c. Spring.
   d. Fire main and spring.

4. Sprinkling system automatic control devices are designed to operate on a rapid rate-of-rise in temperature, at a fixed temperature, or when either condition is present.

   True__________or False____________.

5. The jacking cylinder associated with the sprinkling system automatic control device performs the following functions:

   a. Equalizes pressure in the HAD valve.
   b. Changes pneumatic pressure to mechanical energy.
   c. Converts water pressure to oil (hydraulic) pressure.
   d. Resets the HAD valve.

6. Fixed temperature units (FTU's) used with the sprinkling system automatic control devices cause the HAD valves to function when the temperature in a protected compartment reaches a certain level, regardless of the rate-of-rise.

   True__________or False____________.

7. A manometer is used to measure the pressure developed by the rate-of-rise system.

   True_________or False_____________.

8. The pry-a-larm warning system is activated by one of the following:

   a. Water.
   b. Heat.
   c. Combustion particles.
   d. Light.

9. Carbon dioxide (CO_2) systems are used in launcher carriages and magazines to control all types of fires.

   True_________or False_____________.

10. Normally, the CO_2 system is operated

    a. Electrically.
    b. Hydraulically.
    c. Pneumatically.
    d. Manually.

11. Circle seal check valves are installed in the CO_2 system between the following:

    a. Control heads and CO_2 cylinders.
    b. Discharge heads and control heads.
    c. Control heads and heat sensing devices.
    d. Manual shutoff valve and discharge heads.

12. Melting of the fusible link on the thermosylphon heat sensing device releases the compression spring, causing the

    a. Device housing to expand.
    b. Bellows to expand.
    c. Pressure in the bellows to lower.
    d. Bellows to collapse.

13. Before personnel enters a magazine provided with a CO_2 system, the manual shutoff valve must be set in the OPEN position.

    True_________or False ____________.

Accuracy of notes checked by instructor:

Date ____________________

Trainee's initials ____________________

Sections 13 and 14

ELECTRICITY AND ELECTRONICS

ASSIGNMENTS

Section No.	Section Title	Page
13.	Weapon System Electricity Synchro Servo System Fundamentals	354
14.	Weapon System Electronics	354

ALL TOPICS OF SECTIONS 13 AND 14

You Are Now Going to Learn

Refer to appropriate section of NAVPERS 92662. (See ASSIGNMENTS.)

Discussion Points for these Sections Are:

1. Weapon system electricity.
2. Synchro servo system fundamentals.
3. Weapon system electronics.

ASSIGNMENTS:

A. Reference publications:
   1. Study NAVPERS 92662, Vol. 1, Section 2, Topics 1 through 25.
   2. Study NAVPERS 92662, Vol. 1, Section 3, Topics 1 through 11.
   3. Study NAVPERS 92662, Vol. 2, Section 4, Topics 1 through 18.

INFORMATION AND DISCUSSION:

The discussion points for Sections 13 and 14 are thoroughly covered in the assignments. Study the text carefully and in proper sequence.

Section 15

WEAPONS DEPARTMENT ORGANIZATION

ASSIGNMENT—DISCUSSION—QUIZ SHEETS

Topic No.	Topic Title	Page
1.	Identification and Procurement of Ordnance Material	356
2.	Accountability and Shipboard Stowage of Ordnance Equipment . . .	362
3.	Reports, Records, and Logs	366
4.	Ordnance Equipment Upkeep, Repair, Alterations, and Overhaul Periods	374

TOPIC 1: IDENTIFICATION AND PROCUREMENT OF ORDNANCE MATERIAL

You Are Now Going to Learn:

1. Organization of the Navy supply system.
2. Methods of identifying ordnance material.
3. Procedures required for procurement of ordnance material.

Discussion Points for this Topic Are:

1. Organization of the Navy supply system.
2. Definition of ordnance material.
3. Identification of ordnance material:
    a. Federal Stock Numbers (FSN).
    b. Navy Stock List of the Ordnance Supply Office.
    c. Illustrated Parts Breakdown (IPB) of ordnance equipment.
    d. Naval Ordnance Allowance Lists (NAVORD Lists).
    e. Coordinated Shipboard Allowance List (COSAL).
4. Supply responsibility (shipboard).
5. Requisitioning of ordnance material.
6. Review and summary.

INFORMATION AND DISCUSSION:

The naval supply system is administered by the Bureau of Supply and Accounts (BUSANDA). This management control involves policy making and exercising of general supervision over the performance of supply functions which include cataloging, procurement, stock control, storage, transportation, accounting, issuance, and disposal of various categories of supplies, equipment, and repair parts.

Each bureau of the Navy is charged with the technical direction of the type of material for which that bureau is responsible. Technical direction involves the performance of the technical functions of research, development, design, inspection, and installation of equipment. (The various bureaus and types of equipment they have technical direction of are outlined in the illustration on facing page.) While BUSANDA has management control of all items, it also has technical direction of certain categories of materials.

The Supply Demand Control Points (SDCP's) exercise inventory control over specifically designed categories of material. Each SDPC is under the control of BUSANDA and receives technical direction from the bureau responsible for the type of material assigned.

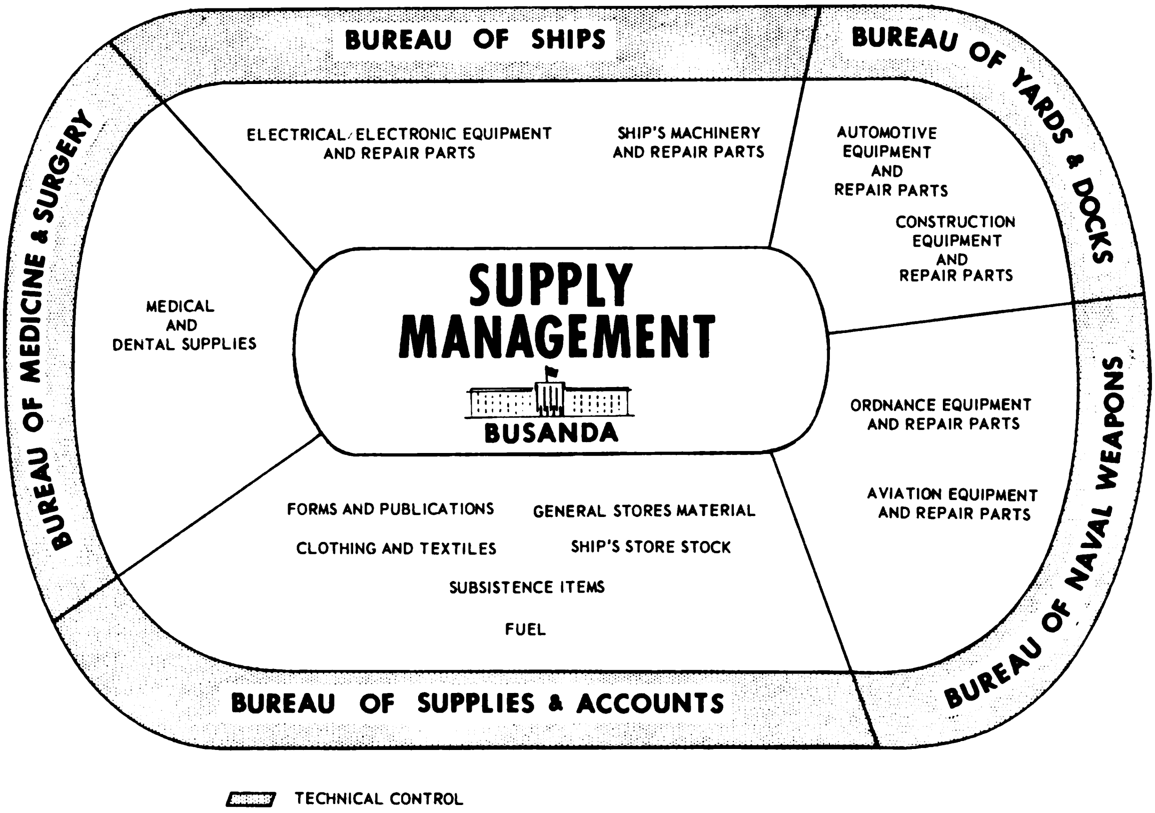
SDCP's are not warehouses and do not carry a selection of stock; these points are mainly concerned with the procurement of stock for direct delivery to supply depots and other field supply activities and with the redistribution of supplies between activities. The SDCP for ordnance material and spare parts is the Ordnance Supply Office (OSO) at Mechanicsburg, Pa.

Supply depots, supply centers, tenders, and store ships are the principal supply sources for individual ships. Supply depots and supply centers are located in major naval ports throughout the world. Tenders and store ships carry a rather limited scope and quantity of supplies, but they insure greater mobility of the Fleet by providing supply support to ships at remote points.

Repair ships do not provide ships with supply support except in emergencies.

Ordnance material consists of ordnance equipment, components, equipage, and supporting repair parts. Ordnance equipment includes guns, projectors, launchers, loaders, and all weapon handling devices. Ordnance components are subassemblies of ordnance equipment. Equipage includes covers, special tools, and test equipment.

Repair parts are manufactured parts of equipment provided to replace worn or damaged parts. The term repair part has lately replaced the term spare part; however, the term spare parts is still used in many publications.


BUREAU OF SHIPS
BUREAU OF YARDS & DOCKS
BUREAU OF NAVAL WEAPONS
BUREAU OF SUPPLIES & ACCOUNTS
BUREAU OF MEDICINE & SURGERY
ELECTRICAL/ELECTRONIC EQUIPMENT AND REPAIR PARTS
SHIP'S MACHINERY AND REPAIR PARTS
AUTOMOTIVE EQUIPMENT AND REPAIR PARTS
CONSTRUCTION EQUIPMENT AND REPAIR PARTS
ORDNANCE EQUIPMENT AND REPAIR PARTS
AVIATION EQUIPMENT AND REPAIR PARTS
MEDICAL AND DENTAL SUPPLIES
SUPPLY MANAGEMENT
BUSANDA
FORMS AND PUBLICATIONS
GENERAL STORES MATERIAL
CLOTHING AND TEXTILES
SHIP'S STORE STOCK
SUBSISTENCE ITEMS
FUEL
▨ TECHNICAL CONTROL

223. COORDINATION OF THE NAVY SUPPLY SYSTEM

Before and during World War II, almost all ordnance equipment was identified by a part number assigned by the manufacturer. Since many standard items of the same kind were made by different companies, the Navy stocked the same kind of parts under different numbers.

After World War II, the Navy supply identification system was reorganized. In this new system, the number, for instance, of ballbearing types listed was reduced by approximately nine hundred. The ordnance stock number in this system consisted of a cognizance symbol, material class code, and a stem or identification number. For instance, Z-010-123456-1 indicated the following:

Z - Who has control of the item (cognizance symbol).

010 - Where the item is used (material class code).

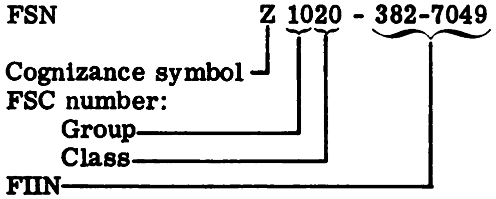
123456-1 - Identification number (stem number).

The stem number used in ordnance equipment is the drawing number. Drawing numbers originate from the blueprint plans for ordnance equipment and constitute the basic means of identification.

Several years later, the 82nd Congress passed a law (436) requiring the supply items used by all military departments (Army, Navy, and Air Force) to be standardized, to eliminate duplication of common use items in the services.

To comply with this law, in 1954 the Defense Department adapted the Federal Supply System. As a result, each supply item now has a single Federal Stock Number (FSN).

An FSN is composed of a cognizance code letter and an 11-digit number. The first four digits represent the Federal Supply Classification (FSC) number; the first two digits indicate the group number, and the second two digits indicate the class number. The last seven digits of the FSN constitute the Federal Item Identification Number (FIIN). Note, the following is a breakdown of the FSN for the loading machine cover (LH) of the 5"/38 Loading Machine Mk 15 Mods 1 and 3.



The cognizance symbols used to identify ordnance material are J, Z, and A. J-items consist of ordnance equipment, components, equipage, and supporting repair parts, and of materials controlled by the Bureau of Naval Weapons. Z- and A-items are ordnance repair parts and materials procured and controlled by the Ordnance Supply Office (OSO), Mechanicsburg, Pa.

The FSC group numbers consist of eighty-nine 2-digit numbers, starting with the number 10. Each group of 2-digit numbers indicates a type of material.

The following list shows the identification of some typical supply materials by their group numbers:

Title	Group
1. Weapons	10
2. Ammunition and Explosives	13
3. Guided missiles	14
4. Bearings	31
5. Handtools	51
6. Office Supplies	75

Each group of materials is broken down into classes. The following breakdown of Group 31 (bearings) illustrates the division of a group into classes:

1. Bearings, Antifriction, unmounted	3110
2. Bearings, Plain, unmounted	3120
3. Bearings, mounted	3130

The Navy Stock List of the Ordnance Supply Office (NSL of OSO) includes a complete listing of naval ordnance material. The list is divided into eight volumes (a portion of Volume 1 is shown in the illustration on facing page) and is normally kept in the supply office. A list of these volumes and their contents follows:

1. Volume 1 - A and Z (cognizance material).
2. Volume 2 - J (cognizance material).
3. Volume 3 - Master Cross-Reference List (MCRL).
4. Volume 4 - Preservation and packaging data.
5. Volume 5 - Synchro Cross-Reference.
6. Volume 6 - Canvas Covers.
7. Volume 7 - Landing Party Equipment.
8. Volume 8 - Special Weapons Material.

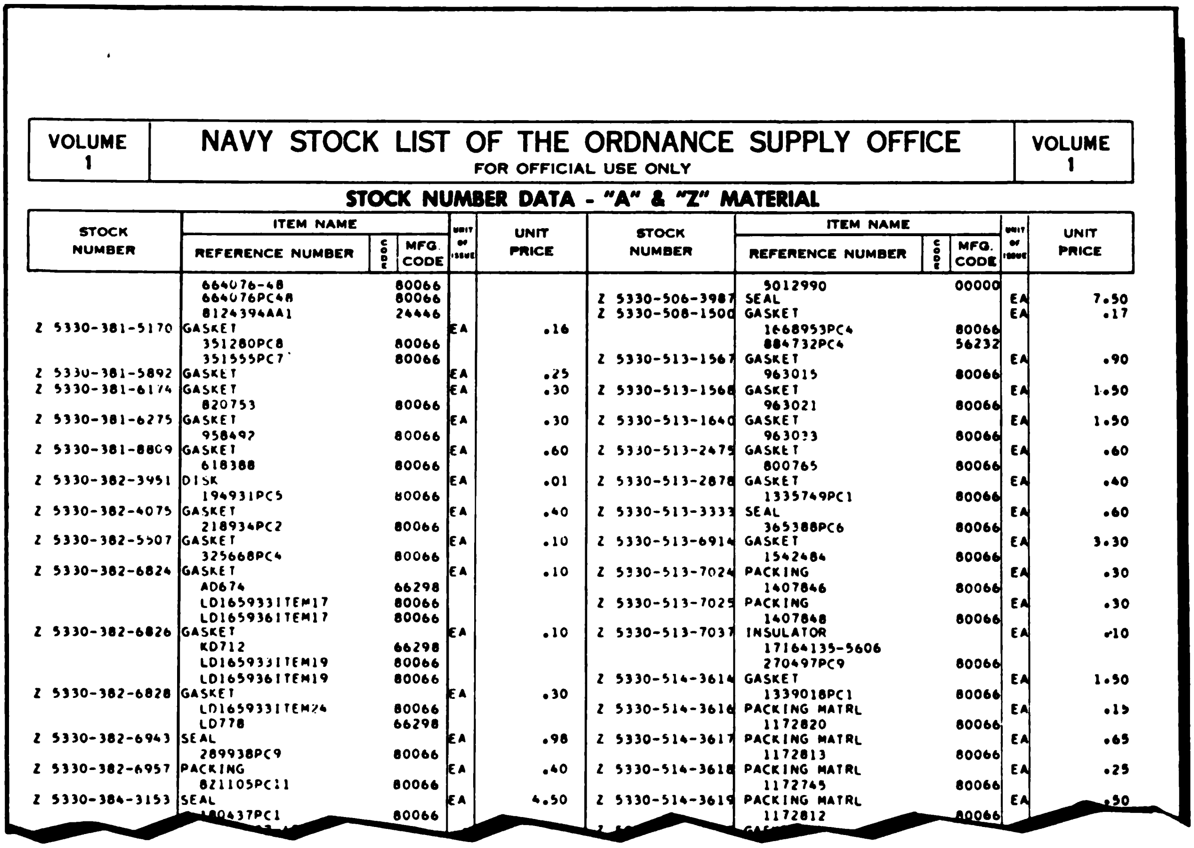
Illustrated Parts Breakdown (IPB) of ordnance equipment is prepared by OSO, under the direction of the Bureau of Naval Weapons.

One IPB is published for each particular type of equipment. The IPB describes and illustrates the relationship of all assemblies and parts comprising an equipment.

The IPB publications are intended for the use of all personnel concerned with the identification, maintenance, and repair of ordnance equipment. IPB 0000 is an index of all IPS's which have been published by OSO. Recently BUWEPS has authorized that IPB's be printed as OP's. For example, OP 1764 - IPB's 1, 2, and 3 show the breakdown of the 5"/54 Mk 42 gun mount and associated equipment. These IPB's are listed in OP 0.

Naval Ordnance Allowance Lists (NAVORD lists) are lists of repair parts for individual ordnance equipment. A NAVORD list is prepared for each ordnance equipment supported by OSO

Two copies of NAVORD lists for each type of ordnance equipment are issued to each ship. One set is kept in the weapons



VOLUME 1 | NAVY STOCK LIST OF THE ORDNANCE SUPPLY OFFICE | VOLUME 1

FOR OFFICIAL USE ONLY

STOCK NUMBER DATA - "A" & "Z" MATERIAL

STOCK NUMBER	ITEM NAME			UNIT OF ISSUE	UNIT PRICE
	REFERENCE NUMBER	CODE	MFG. CODE		
	664076-48		80066		
	664076PC48		80066		
	8124394AA1		24446		
Z 5330-381-5170	GASKET			EA	.16
	351280PC8		80066		
	351555PC7		80066		
Z 5330-381-5892	GASKET			EA	.25
Z 5330-381-6174	GASKET			EA	.30
	820753		80066		
Z 5330-381-6275	GASKET			EA	.30
	958492		80066		
Z 5330-381-8809	GASKET			EA	.60
	618388		80066		
Z 5330-382-3951	DISK			EA	.01
	194931PC5		80066		
Z 5330-382-4075	GASKET			EA	.40
	218934PC2		80066		
Z 5330-382-5507	GASKET			EA	.10
	325668PC4		80066		
Z 5330-382-6824	GASKET			EA	.10
	AD674		66298		
	LD165933ITEM17		80066		
	LD165936ITEM17		80066		
Z 5330-382-6826	GASKET			EA	.10
	KD712		66298		
	LD165933ITEM19		80066		
	LD165936ITEM19		80066		
Z 5330-382-6828	GASKET			EA	.30
	LD165933ITEM24		80066		
	LD778		66298		
Z 5330-382-6943	SEAL			EA	.98
	289938PC9		80066		
Z 5330-382-6957	PACKING			EA	.40
	821105PC11		80066		
Z 5330-384-3153	SEAL			EA	4.50
	180437PC1		80066		

STOCK NUMBER	ITEM NAME			UNIT OF ISSUE	UNIT PRICE
	REFERENCE NUMBER	CODE	MFG. CODE		
	5012990		00000		
Z 5330-506-3987	SEAL			EA	7.50
Z 5330-508-1500	GASKET			EA	.17
	1668953PC4		80066		
	884732PC4		56232		
Z 5330-513-1567	GASKET			EA	.90
	963015		80066		
Z 5330-513-1568	GASKET			EA	1.50
	963021		80066		
Z 5330-513-1640	GASKET			EA	1.50
	963033		80066		
Z 5330-513-2475	GASKET			EA	.60
	800765		80066		
Z 5330-513-2878	GASKET			EA	.40
	1335749PC1		80066		
Z 5330-513-3333	SEAL			EA	.60
	365388PC6		80066		
Z 5330-513-6914	GASKET			EA	3.30
	1542484		80066		
Z 5330-513-7024	PACKING			EA	.30
	1407846		80066		
Z 5330-513-7025	PACKING			EA	.30
	1407848		80066		
Z 5330-513-7037	INSULATOR			EA	.10
	17164135-5606				
	270497PC9		80066		
Z 5330-514-3614	GASKET			EA	1.50
	1339018PC1		80066		
Z 5330-514-3616	PACKING MATRL			EA	.15
	1172820		80066		
Z 5330-514-3617	PACKING MATRL			EA	.65
	1172813		80066		
Z 5330-514-3618	PACKING MATRL			EA	.25
	1172745		80066		
Z 5330-514-3619	PACKING MATRL			EA	.50
	1172812		80066		

224. SECTION OF PAGE FROM NSL OF OSO, VOLUME 1

office, and the other is kept in the supply office.

The complete file of applicable NAVORD lists makes up the Shipboard Ordnance Allowance List.

A typical NAVORD list provides the following information:

1. Identification of the basic equipment, with Mk and Mod numbers, FSN's, and identification (drawing) numbers.

2. Listing of repair parts, tools, accessories, and materials that make up a full set of repair parts for the various components of the equipment.

3. A key showing how many full sets of materials are required. The number of sets required depends on how many units of the equipment are installed aboard ship.

Indexes to the NAVORD list are found in NAVSANDA publication 2002, Navy Stock Lists of Forms, Cog Symbol I, Section 11.

A relatively recent improvement of the Navy Allowance List program is Coordinated Shipboard Allowance List (COSAL). This list is tailored to apply to an individual ship and is prepared in segments, according to the category of material, in a simplified and uniform format. Each category is listed in a separate section. Each section is divided into the following parts:

1. Introduction.

2. An index of equipment and equipage (Part I).

3. A set of allowance parts lists (Part II).

4. A stock number sequence list (Part III).

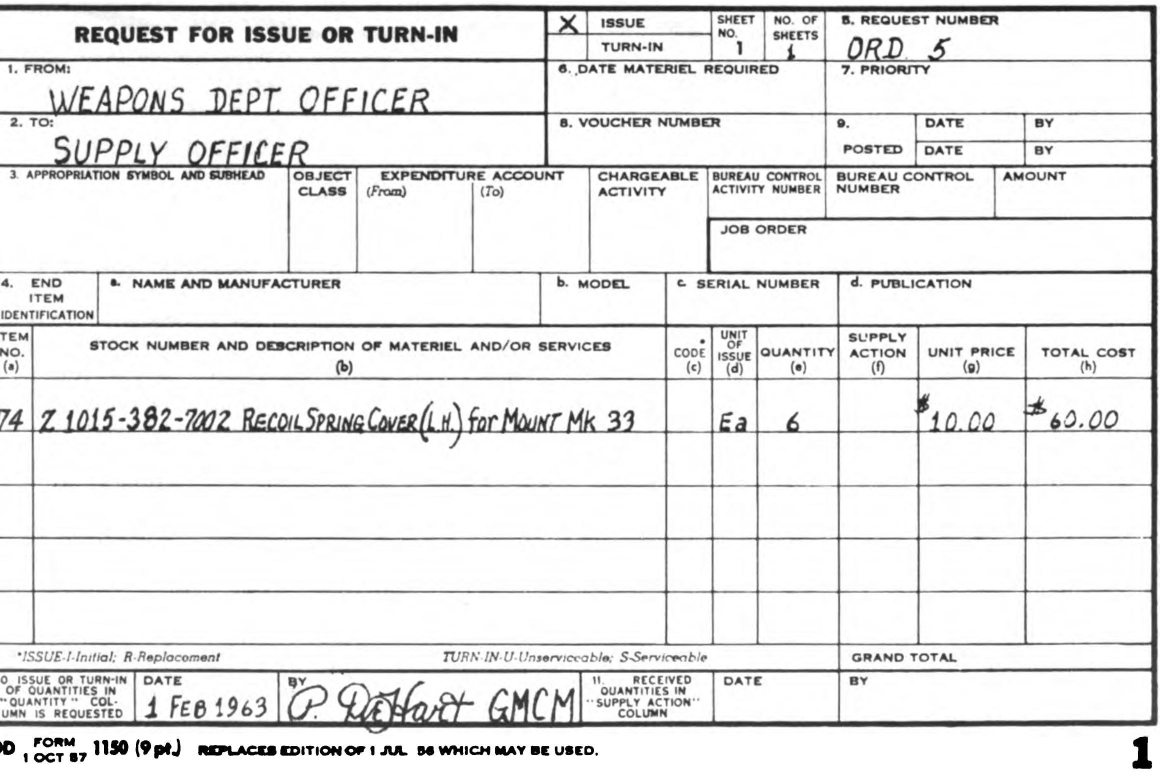
Chapter 4 of the introduction to COSAL
lescribes the format, defines the terms
ised, and provides general information about
he issuance and maintenance of the ord-
ance portion of COSAL.

Part I of COSAL is an index of installed
nd portable equipment and/or components
nd equipage. Part II of COSAL consists of
he Allowance Parts List (APL) for each
quipment or equipage category listed in
Part I of COSAL. Part III of COSAL is a
onsolidated stock number sequence list of
nboard repair parts listed in Part II. Part
II also indicates whether other equipment
board ship (guns, GMLS's, fire control,
ngineering, or electronics) uses the same
epair parts.

The ordnance supply responsibility de-
ends on whether the ship is equipped with
entral storerooms or not. Aboard ships
vith central storerooms (almost all ships,
estroyer size and larger, already have or
vill have central storerooms), ordnance
naterial and most repair parts for all departments are in custody and under control of the supply officer. The supply office keeps stock records for each item in the central storeroom and records each receipt and issue of material, in order to estimate the future requirements of the ship for the items.

In ships without central storerooms, the ordnance material and repair parts when they are received aboard ship are turned over to heads of departments. Wherever space permits, each department maintains its own storeroom. Aboard many such ships without central storerooms, the supply officers have custory of and procurement responsibility for the repair parts that are stored in drawers and bins.

The form used to request material from the ship supply department is the Request for Issue or Turn-In, DD Form 1150 shown in the illustration below. This form may also be used for requesting the supply department to procure materials from sources outside the ship.



REQUEST FOR ISSUE OR TURN-IN

☒ ISSUE
☐ TURN-IN
SHEET NO. 1
NO. OF SHEETS 1
5. REQUEST NUMBER ORD 5
1. FROM: WEAPONS DEPT OFFICER
6. DATE MATERIEL REQUIRED
7. PRIORITY
2. TO: SUPPLY OFFICER
8. VOUCHER NUMBER
9. POSTED DATE BY DATE BY

3. APPROPRIATION SYMBOL AND SUBHEAD	OBJECT CLASS	EXPENDITURE ACCOUNT (From)	(To)	CHARGEABLE ACTIVITY	BUREAU CONTROL ACTIVITY NUMBER	BUREAU CONTROL NUMBER	AMOUNT
					JOB ORDER		

4. END ITEM IDENTIFICATION	a. NAME AND MANUFACTURER	b. MODEL	c. SERIAL NUMBER	d. PUBLICATION

TEM NO. (a)	STOCK NUMBER AND DESCRIPTION OF MATERIEL AND/OR SERVICES (b)	CODE* (c)	UNIT OF ISSUE (d)	QUANTITY (e)	SUPPLY ACTION (f)	UNIT PRICE (g)	TOTAL COST (h)
74	Z 1015-382-7002 Recoil Spring Cover (L.H.) for Mount Mk 33		Ea	6		$10.00	$60.00

*ISSUE-I-Initial; R-Replacement TURN-IN-U-Unserviceable; S-Serviceable GRAND TOTAL

0 ISSUE OR TURN-IN OF QUANTITIES IN "QUANTITY" COL-UMN IS REQUESTED	DATE 1 FEB 1963	BY P. DeHart GMCM	11. RECEIVED QUANTITIES IN "SUPPLY ACTION" COLUMN	DATE	BY

D FORM 1 OCT 57 1150 (9 pt.) REPLACES EDITION OF 1 JUL 56 WHICH MAY BE USED.

1

225. REQUEST FOR ISSUE OR TURN-IN, DD FORM 1150

The Federal Stock Number (FSN) is the most important means of identification for any item; therefore, it should be accurately listed on the DD 1150. If the FSN is not available, S. and A. Form 302 should be submitted instead of DD 1150, since Form 302 provides space for additional identification data. When filling out Form 302, list all available data to help the supply department to identify the item.

If the weapons department has custody of any repair parts, replacement parts should be requested immediately from the supply department, to replace used repair parts. This is necessary to insure that parts will be available the next time they are needed.

IDENTIFICATION AND PROCUREMENT OF ORDNANCE EQUIPMENT

TOPIC 2: ACCOUNTABILITY AND SHIPBOARD STOWAGE OF ORDNANCE EQUIPMENT

ou Are Now Going to Learn:

- Methods and types of accountability of shipboard ordnance equipment.
- Shipboard stowage of ordnance equipment.

iscussion Points for this Topic Are:

- Types of accountability of ordnance equipment.
- Shipboard stowage of ordnance equipment.
- Review and summary.

NFORMATION AND DISCUSSION:

Gunner's mates are not expected to know s much about supplies as storekeepers; owever, gunner's mates may be assigned to he storerooms, to assist the supply departnent personnel in the stowage of ordnance epair parts or may be in charge of an ordance storeroom. Under these circumstances, t is the duty of the gunner's mate to make ure that the ordnance repair parts are roperly stored.

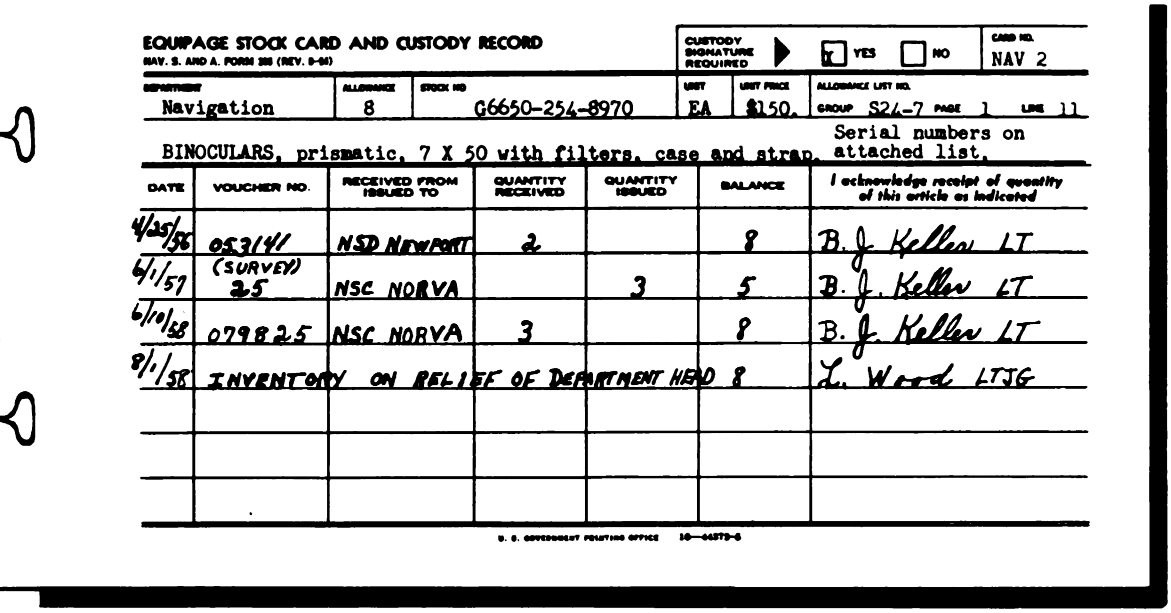
Wherever possible, repair parts are stored in special storerooms. The physical layout of these storerooms depends largely on the space available on each ship.

On most combat vessels, the supply department has a central storeroom. Through this central storeroom, the supply department handles all ordnance repair part ordering, storing, distribution, and inventory.

On some ships, the weapons department through its storerooms may take care of the ordnance repair parts and perform the same functions, except for the actual ordering, as the supply department through its central storerooms on other ships.

The supply department must maintain a complete record of all ordnance equipage requiring a custody signature. These records are kept on Equipage Stock Card and Custody Record, (S. and A. Form 306), formsheets. (Refer to the illustration below.)

> NOTE: Ordnance equipage is any material designated as such by the Bureau of Weapons. The term equipage is used to identify assemblies not consumed or appreciably



EQUIPAGE STOCK CARD AND CUSTODY RECORD
NAV. S. AND A. FORM 306 (REV. 8-54)

CUSTODY SIGNATURE REQUIRED ▶ ☒ YES ☐ NO

CARD NO. NAV 2

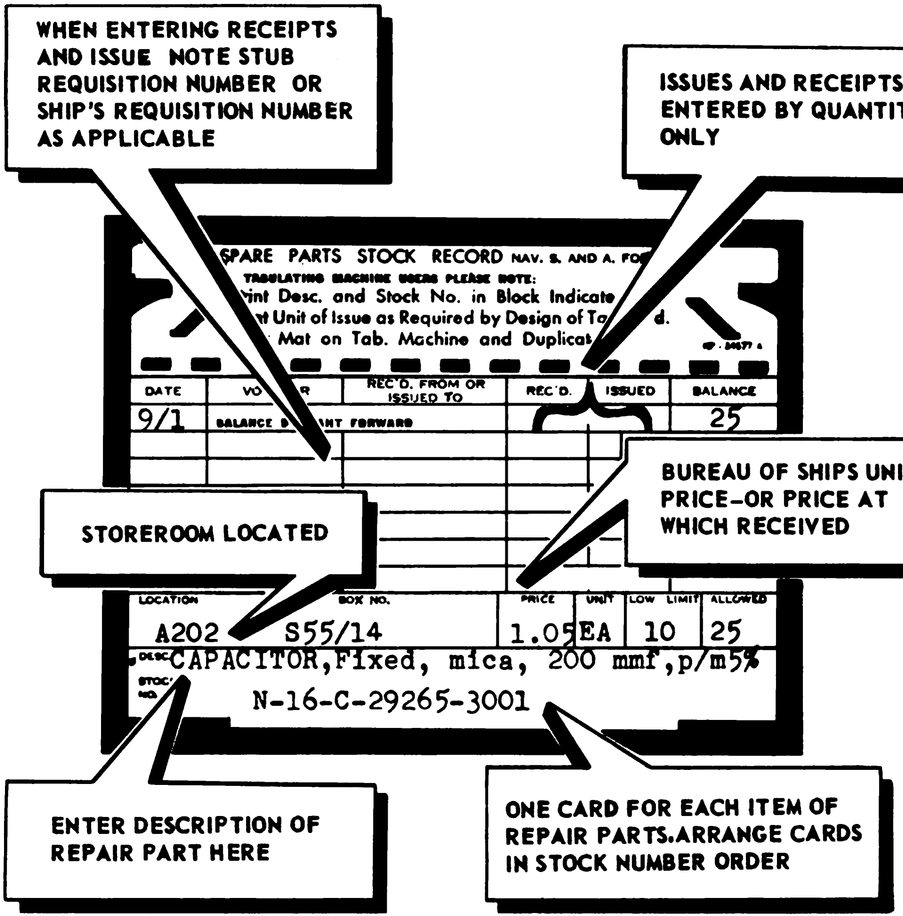
DEPARTMENT	ALLOWANCE	STOCK NO	UNIT	UNIT PRICE	ALLOWANCE LIST NO.
Navigation	8	G6650-254-8970	EA	$150.	GROUP S24-7 PAGE 1 LINE 11

BINOCULARS, prismatic, 7 X 50 with filters, case and strap. Serial numbers on attached list.

DATE	VOUCHER NO.	RECEIVED FROM ISSUED TO	QUANTITY RECEIVED	QUANTITY ISSUED	BALANCE	I acknowledge receipt of quantity of this article as indicated
4/25/56	053141	NSD NEWPORT	2		8	B. J. Keller LT
6/1/57	(SURVEY) 25	NSC NORVA		3	5	B. J. Keller LT
6/10/58	079825	NSC NORVA	3		8	B. J. Keller LT
8/1/58	INVENTORY ON RELIEF OF DEPARTMENT HEAD				8	L. Wood LTJG

U. S. GOVERNMENT PRINTING OFFICE 16—64573-6

226. EQUIPAGE STOCK CARD AND CUSTODY RECORD (S. AND A. FORM 306)



WHEN ENTERING RECEIPTS AND ISSUE NOTE STUB REQUISITION NUMBER OR SHIP'S REQUISITION NUMBER AS APPLICABLE

ISSUES AND RECEIPTS ENTERED BY QUANTITY ONLY

SPARE PARTS STOCK RECORD NAV. S. AND A. FO

TABULATING MACHINE USERS PLEASE NOTE:

int Desc. and Stock No. in Block Indicate

t Unit of Issue as Required by Design of Ta d.

Mat on Tab. Machine and Duplicat

DATE | VO R | REC'D. FROM OR ISSUED TO | REC'D. | ISSUED | BALANCE

9/1 BALANCE B NT FORWARD 25

BUREAU OF SHIPS UNIT PRICE-OR PRICE AT WHICH RECEIVED

STOREROOM LOCATED

LOCATION A202 | BOX NO. S55/14 | PRICE 1.05 | UNIT EA | LOW LIMIT 10 | ALLOWED 25

DESC. CAPACITOR, Fixed, mica, 200 mmf, p/m5%

STOCK NO. N-16-C-29265-3001

ENTER DESCRIPTION OF REPAIR PART HERE

ONE CARD FOR EACH ITEM OF REPAIR PARTS.ARRANGE CARDS IN STOCK NUMBER ORDER

S.AA. FORM 488-SPARE PARTS STOCK RECORD USED AS THE STOCK CONTROL RECORD FOR THE FOLLOWING:

ELECTRONIC REPAIR PARTS	ORDNANCE REPAIR PARTS
SHIP'S MACHINERY REPAIR PARTS	(DRAWER-AND SHELF-STOWED ONLY

227. SPARE PARTS STOCK RECORD (S. AND A. FORM 488)

altered while in use. Usually, equipage is of greater functional importance and value than supplies.

The S. and A. Form 306 is prepared in an original and one copy. Originals, signed by the weapons officer, are kept by the supply officer. Duplicates are kept by department heads who have custody of the material.

S. and A. Form 306 serves a dual purpose:

1. As a custody record.
2. As an inventory control document for equipage requiring a custody signature.

For equipage not requiring a custody signature, S. and A. Form 306 is optional.

An annual inventory is taken during each fiscal year. (The fiscal year begins 1 July and ends the following 30 June.) The date when inventory is to be taken is set by the supply officer. The department head (weapons officer) is responsible for inventory of ordnance material over which he has custody.

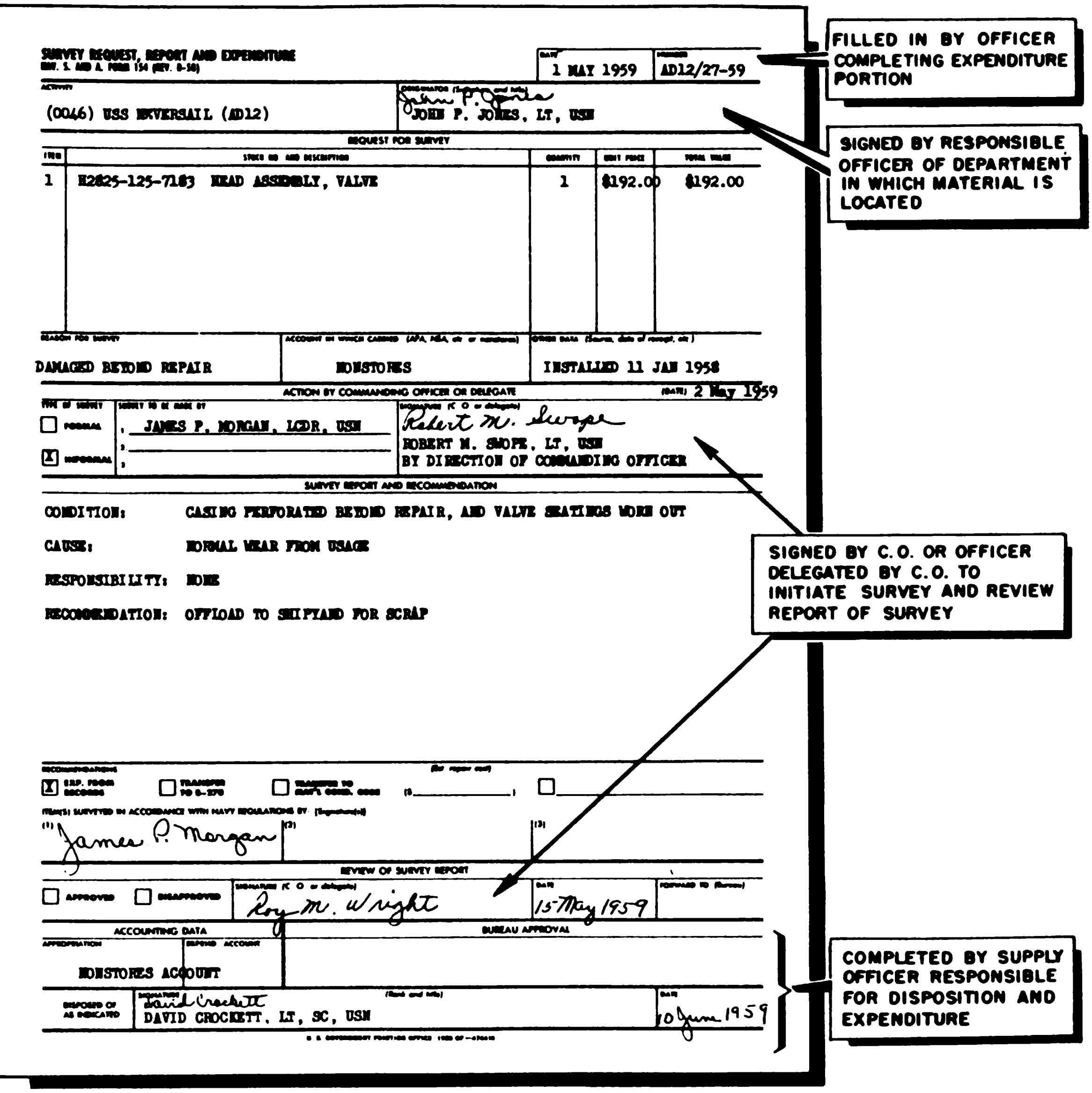
For each ordnance repair part carried onboard ship, the supply officer must prepare and maintain a Spare Parts Stock ecord, (S. and A. Form 488). The S. and . Form 488 must contain stock number, rief description, storage location, unit of ssue, and allowed quantity of each part. reparation of a Spare Parts Stock Record, S. and A. Form 488) is shown in the illus- ration on preceding page.

NOTE: The space available for stowage of ordnance material varies from ship to ship; therefore, no definite procedures can be set up for stowage of ordnance material on all types of ships.

Some factors to be considered in the stowing of and accounting for spare parts follow:

1. Maximum stowage capacity.

2. Access to all stored repair parts.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE	1 MAY 1959
NUMBER	AD12/27-59
ACTIVITY	(0046) USS UNVERSAIL (AD12)
ORIGINATOR (Signature and title)	John P. Jones JOHN P. JONES, LT, USN

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1	H2825-125-7183 HEAD ASSEMBLY, VALVE	1	$192.00	$192.00

REASON FOR SURVEY	ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores)	OTHER DATA (Source, date of receipt, etc.)
DAMAGED BEYOND REPAIR	NONSTORES	INSTALLED 11 JAN 1958

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE) 2 May 1959

TYPE OF SURVEY	SURVEY TO BE MADE BY	SIGNATURE (C O or delegate)
☐ FORMAL ☒ INFORMAL	1. JAMES P. MORGAN, LCDR, USN 2. 3.	Robert M. Swope ROBERT M. SWOPE, LT, USN BY DIRECTION OF COMMANDING OFFICER

SURVEY REPORT AND RECOMMENDATION

CONDITION: CASING PERFORATED BEYOND REPAIR, AND VALVE SEATINGS WORN OUT

CAUSE: NORMAL WEAR FROM USAGE

RESPONSIBILITY: NONE

RECOMMENDATION: OFFLOAD TO SHIPYARD FOR SCRAP

RECOMMENDATIONS

☒ EXP. FROM RECORDS ☐ TRANSFER TO S-270 ☐ TRANSFER TO MAT'L COND. CODE (For repair cost) ($) ☐

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY (Signature(s))

(1) James P. Morgan (2) (3)

REVIEW OF SURVEY REPORT

	SIGNATURE (C O or delegate)	DATE	FORWARD TO (Bureau)
☐ APPROVED ☐ DISAPPROVED	Roy M. Wright	15 May 1959	

ACCOUNTING DATA — BUREAU APPROVAL

APPROPRIATION	EXPEND ACCOUNT	BUREAU APPROVAL
NONSTORES ACCOUNT		

DISPOSED OF AS INDICATED	SIGNATURE (Rank and title)	DATE
	David Crockett DAVID CROCKETT, LT, SC, USN	10 June 1959

FILLED IN BY OFFICER COMPLETING EXPENDITURE PORTION

SIGNED BY RESPONSIBLE OFFICER OF DEPARTMENT IN WHICH MATERIAL IS LOCATED

SIGNED BY C.O. OR OFFICER DELEGATED BY C.O. TO INITIATE SURVEY AND REVIEW REPORT OF SURVEY

COMPLETED BY SUPPLY OFFICER RESPONSIBLE FOR DISPOSITION AND EXPENDITURE

228. SURVEY REQUEST, REPORT, AND EXPENDITURE (S. AND A. FORM 154)

3. Orderly arrangement of all repair parts.

4. Security and safety of stores.

To eliminate the necessity of shifting material from one place to another during issuing, repair parts should be stowed in bins, racks, or shelves which allow easy access to the material. Items with the greatest turnover should be the most accessible ones and should be stowed as near as possible to the area where they are normally used. Bulky or heavy materials should be stowed in areas where handling could be kept at a minimum.

Ordnance material rendered unless due to damage and wear or material stolen or missing for other reasons must be surveyed, in order to obtain proper authority to write the material off the books. These surveys may be either formal or informal. The type of survey to be made depends on the value of the material and the circumstances under which the material has been lost to use.

Survey requests must made on Survey Request, Report, and Expenditure, S. and A. Form 154. The information required on this form is shown in the illustration on facing page.

TOPIC 3: REPORTS, RECORDS, AND LOGS

ou Are Now Going to Learn:

Types and purpose of reports, records, and logs.

Information required in reports, records, and logs.

scussion Points for this Topic Are:

Definition of reports.

Types and purpose of reports.

Types and purpose of records.

Types and purpose of logs:

a. Ordnance history.
b. Battery log.
c. Small arms log.
d. Ballistics log.
e. Magazine temperature log.

Review and summary.

FORMATION AND DISCUSSION:

Normally, a gunner's mate is not re- ired to make the reports discussed in this pic. However, in most cases, gunner's ates will be assigned the task of obtaining e information required for making the ports.

The Bureau of Weapons must be kept formed of the condition and location of all dnance equipment in service. In order accurately anticipate the demand for uipment, spare parts, and supplies, JWEPS must be furnished with an actual unt of these items. This information nstitutes only part of what must be ported.

Reports can be defined as any narrative, bular, or graphic type of information ansmitted from one officer or command another.

The various reports provide an accurate cord of all material issued and of all aterial on hand. Reports insure compliance with war plans and are used to collect data required by the Navy Department for other bureaus.

Reports may be of the following three types:

1. Periodic report - conveys essentially the same information at prescribed intervals.
2. Situation report - submitted when an event or situation of prescribed characteristics occurs; this report may be submitted more than once, but is not periodic.
3. One-time report - prepared once only.

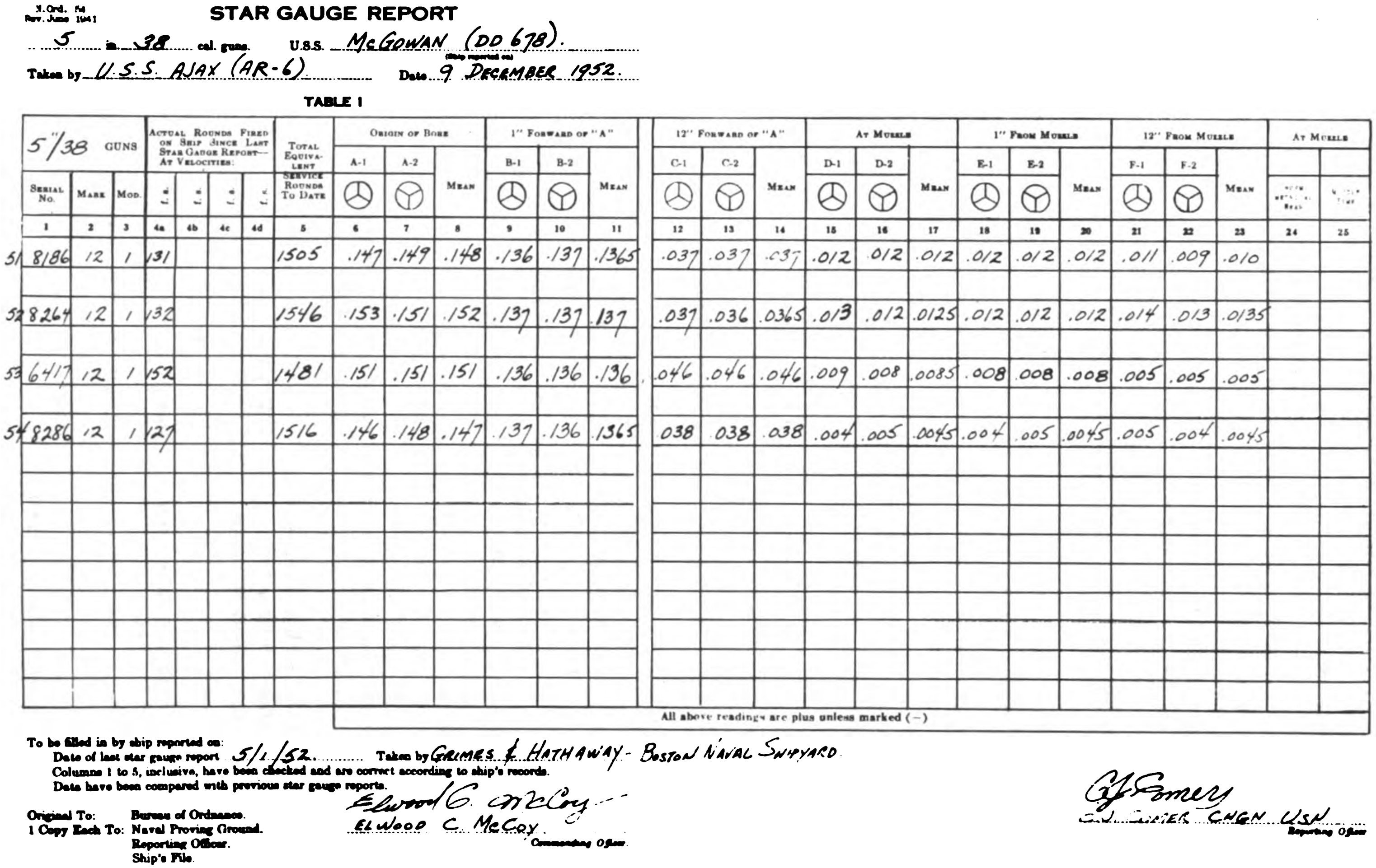
In the following text, a few of the required reports and records used by the weapons department will be discussed.

In order that BUWEPS may be kept informed of the condition of the bore of each gun installed on ships in service, an annual star gauge report must be submitted to the Bureau. Star gauging is normally done by the yard force while the ship is in a shipyard or by a special star gauging party when the ship is alongside a repair ship. However, gunner's mates are required to assist in the star gauging.

When the star gauging is completed, the data are recorded on NAVORD Form 54, shown in the illustration on facing page. The report is then sent to BUWEPS. One copy is sent to the Navy Proving Grounds.

BUWEPS has recently adapted a new procedure for reporting ordnance alterations. Commands concerned are furnished with a printed master armament configuration listing of installed shipboard nonexpendable equipment and the status of pertinent NAVWEPS ordnance (OrdAlt). This listing is called Ship's Armament Inventory List (SAIL), NAVWEPS Form 8000/15, and is produced on data processing equipment.

Newly issued OrdAlts are added to SAIL monthly; however, a new SAIL is not



N. Ord. 54
Rev. June 1941

STAR GAUGE REPORT

5 in. 38 cal. guns. U.S.S. McGOWAN (DD 678).
(Ship reported on)
Taken by U.S.S. AJAX (AR-6) Date 9 DECEMBER 1952.

TABLE 1

	5"/38 GUNS			Actual Rounds Fired on Ship Since Last Star Gauge Report—At Velocities:				Total Equivalent Service Rounds To Date	Origin of Bore			1" Forward of "A"			12" Forward of "A"			At Muzzle			1" From Muzzle			12" From Muzzle			At Muzzle	
	Serial No.	Mark	Mod.						A-1	A-2	Mean	B-1	B-2	Mean	C-1	C-2	Mean	D-1	D-2	Mean	E-1	E-2	Mean	F-1	F-2	Mean		
	1	2	3	4a	4b	4c	4d	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
51	8186	12	1	131				1505	.147	.149	.148	.136	.137	.1365	.037	.037	.037	.012	.012	.012	.012	.012	.012	.011	.009	.010		
52	8264	12	1	132				1546	.153	.151	.152	.137	.137	.137	.037	.036	.0365	.013	.012	.0125	.012	.012	.012	.014	.013	.0135		
53	6417	12	1	152				1481	.151	.151	.151	.136	.136	.136	.046	.046	.046	.009	.008	.0085	.008	.008	.008	.005	.005	.005		
54	8286	12	1	127				1516	.146	.148	.147	.137	.136	.1365	038	038	.038	.004	.005	.0045	.004	.005	.0045	.005	.004	.0045		

All above readings are plus unless marked (−)

To be filled in by ship reported on:
Date of last star gauge report 5/1/52. Taken by GRIMES & HATHAWAY - BOSTON NAVAL SHIPYARD
Columns 1 to 5, inclusive, have been checked and are correct according to ship's records.
Data have been compared with previous star gauge reports.

Elwood C. McCoy
ELWOOD C. McCOY
Commanding Officer

C. J. [illegible] CHGN USN
Reporting Officer

Original To: Bureau of Ordnance.
1 Copy Each To: Naval Proving Ground.
Reporting Officer.
Ship's File.

229. STAR GAUGE REPORT (NAVORD FORM 54)

de out each time a new OrdAlt is ued.

NOTE: OrdAlts will continue to be entered in the ordnance history.

Upon completion of overhaul, the ship pons department makes corrections, itions, or deletions to SAIL and forwards copy to BUWEPS. BUWEPS processes copy for correctness. From this infor- tion a new SAIL is printed and distributed he ship.

Changes made at times other than during pyard overhaul on the status of reportable expendable ordnance equipment installed ard ship or of completion of an OrdAlt ll be reported as they occur on Ship's nament Inventory List (SAIL) Change port, NAVWEPS Form 8000/19 (Ordnance ipment includes missile launchers, rets, mounts, rocket launchers, projec- s, torpedo tubes and depth charge release ipment, fire control equipment, target ignation systems and weapons direction tems, missile test and telemetering ipment, and target control systems.)

These reports are necessary because Bureau must at all times have an up to e listed inventory and OrdAlt status for h ship.

Normally, an inventory and report of all all arms onboard ship is made annually. er the inventory is taken, the data are ered on the Small Arms Inventory Report, D 771, and submitted to the Navy Ord- ce Supply Office. (The Small Arms entory Report, OSO 771, is shown in the stration on the facing page.)

Records of ammunition components on- rd ship are kept by the gunnery officer a responsible assistant. Receipts and expenditures must be entered as they occur, and the authority for receipts and expenditures must be stated.

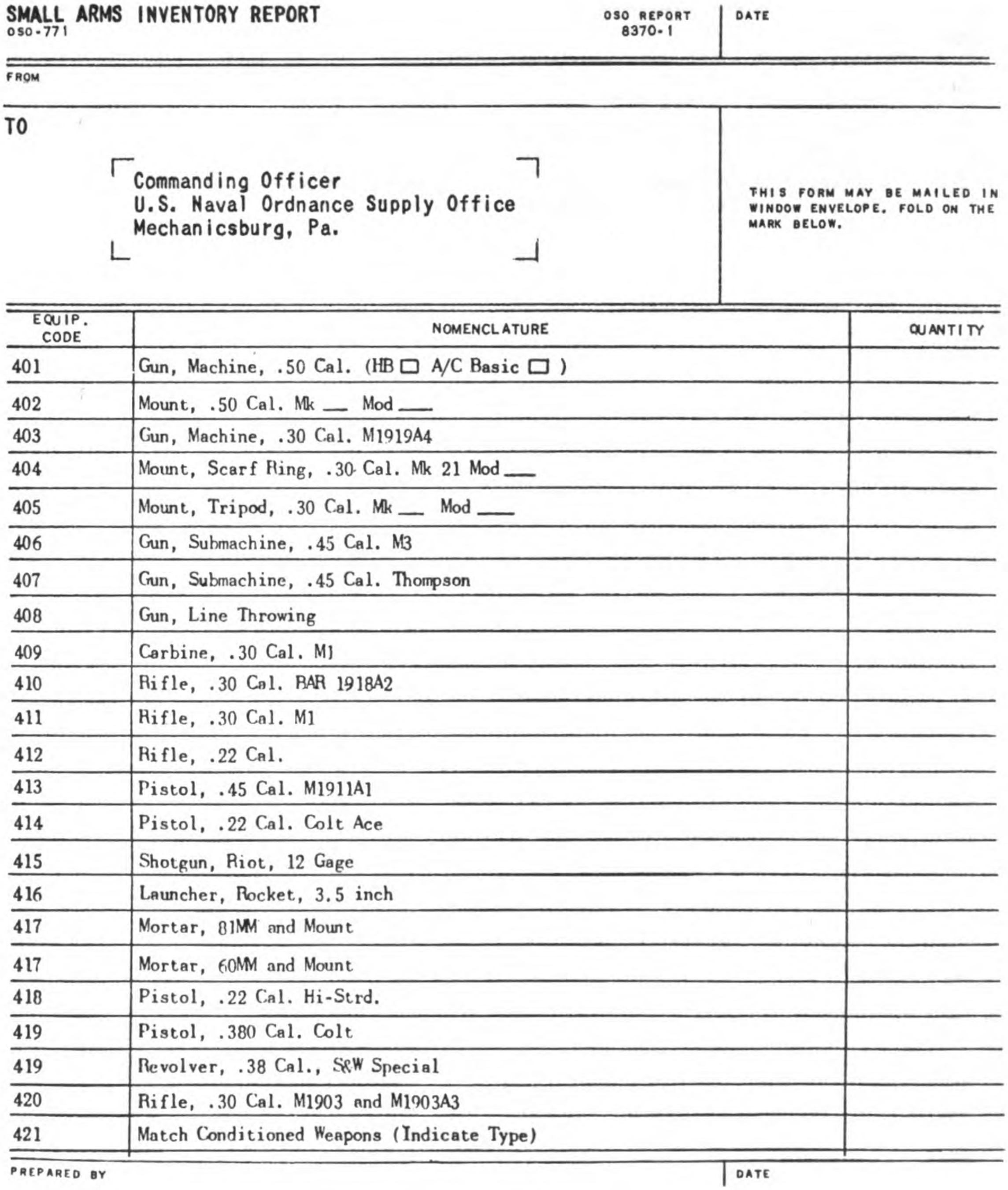
BUWEPS has set up a new procedure for compiling ammunition records on a new type of ammunition data card. NAVWEPS Form 8010/1. Activities preparing these cards shall use the front of the form. On this card, space is provided for a full description of the ammunition, including type, index of powder, lot number, Mk and Mod numbers, date of assembly, etc.

The ship weapons department which receives copies of these cards shall file the cards and keep records of receipts and expenditures on the reverse side of the cards.

The weapons department sends in an initial report on ammunition, including both service and training allowance. This report must show the amount of ammunition on hand on the cutoff date of the report and the expenditures from the beginning of the fiscal year to the cutoff date.

Upon receipt of the initial report, the Fleet Ammunition Report Processing Center prepares on BUWEPS Form 8015/3 (M) a tabulated listing of the information submitted. Copies of this listing are mailed back to the ship within about 20 days. This list and all copies shall be corrected to indicate any changes that have occurred since the prior report and shall be held onboard ship.

An updated copy is returned quarterly to the Fleet Ammunition Report Processing Center where it is used for development of a revised tabulated listing. This listing is then sent back to the ship for further updating and is returned to the Fleet Ammunition Report Processing Center at the end of the next quarter.



SMALL ARMS INVENTORY REPORT
OSO-771

OSO REPORT
8370-1

DATE

FROM

TO

Commanding Officer
U.S. Naval Ordnance Supply Office
Mechanicsburg, Pa.

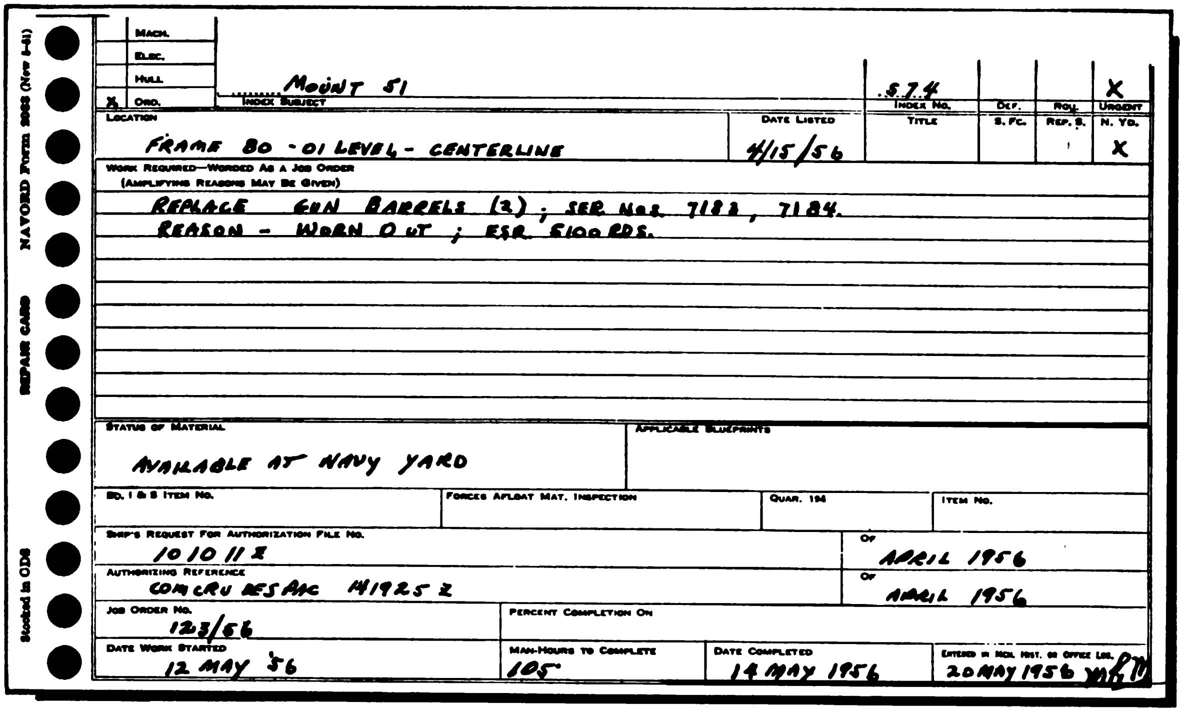
THIS FORM MAY BE MAILED IN WINDOW ENVELOPE. FOLD ON THE MARK BELOW.

EQUIP. CODE	NOMENCLATURE	QUANTITY
401	Gun, Machine, .50 Cal. (HB ☐ A/C Basic ☐)	
402	Mount, .50 Cal. Mk ___ Mod ___	
403	Gun, Machine, .30 Cal. M1919A4	
404	Mount, Scarf Ring, .30 Cal. Mk 21 Mod ___	
405	Mount, Tripod, .30 Cal. Mk ___ Mod ___	
406	Gun, Submachine, .45 Cal. M3	
407	Gun, Submachine, .45 Cal. Thompson	
408	Gun, Line Throwing	
409	Carbine, .30 Cal. M1	
410	Rifle, .30 Cal. BAR 1918A2	
411	Rifle, .30 Cal. M1	
412	Rifle, .22 Cal.	
413	Pistol, .45 Cal. M1911A1	
414	Pistol, .22 Cal. Colt Ace	
415	Shotgun, Riot, 12 Gage	
416	Launcher, Rocket, 3.5 inch	
417	Mortar, 81MM and Mount	
417	Mortar, 60MM and Mount	
418	Pistol, .22 Cal. Hi-Strd.	
419	Pistol, .380 Cal. Colt	
419	Revolver, .38 Cal., S&W Special	
420	Rifle, .30 Cal. M1903 and M1903A3	
421	Match Conditioned Weapons (Indicate Type)	

PREPARED BY

DATE

230. SMALL ARMS INVENTORY REPORT, OSO 771



NAVORD Form 2033 (New 5-51)

REPAIR CARD

Mach.
Elec.
Hull
X Ord.

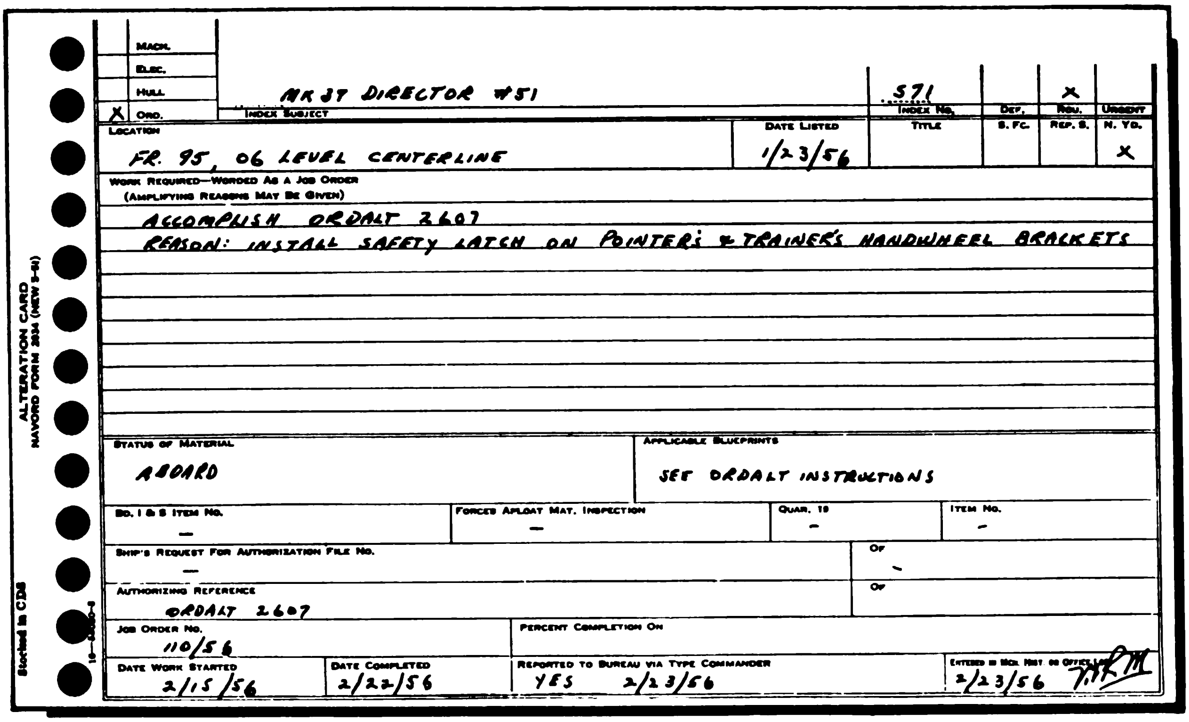
Index Subject: MOUNT 51
Index No.: .574
Def.:
Rou.:
Urgent: X
Location: FRAME 80 - 01 LEVEL - CENTERLINE
Date Listed: 4/15/56
Title:
S. Fc.:
Rep. S.:
N. Yd.: X

Work Required—Worded As a Job Order (Amplifying Reasons May Be Given):
REPLACE GUN BARRELS (2); SER NOS 7183, 7184.
REASON - WORN OUT; ESR 5100 RDS.

Status of Material: AVAILABLE AT NAVY YARD
Applicable Blueprints:
Bu. I & S Item No.:
Forces Afloat Mat. Inspection:
Quar. 194
Item No.:
Ship's Request For Authorization File No.: 101011 Z
Of: APRIL 1956
Authorizing Reference: COMCRUDESPAC 141925 Z
Of: APRIL 1956
Job Order No.: 123/56
Percent Completion On:
Date Work Started: 12 MAY 56
Man-Hours to Complete: 105
Date Completed: 14 MAY 1956
Entered in Mch. Hist. or Office Log.: 20 MAY 1956

Stocked in ODS

231. ORDNANCE REPAIR CARD, NAVORD FORM 2033



ALTERATION CARD
NAVORD FORM 2034 (NEW 5-51)

Mach.
Elec.
Hull
X Ord.

Index Subject: MK 37 DIRECTOR #51
Index No.: 571
Def.:
Rou.: X
Urgent:
Location: FR. 95, 06 LEVEL CENTERLINE
Date Listed: 1/23/56
Title:
S. Fc.:
Rep. S.:
N. Yd.: X

Work Required—Worded As a Job Order (Amplifying Reasons May Be Given):
ACCOMPLISH ORDALT 2607
REASON: INSTALL SAFETY LATCH ON POINTER'S & TRAINER'S HANDWHEEL BRACKETS

Status of Material: ABOARD
Applicable Blueprints: SEE ORDALT INSTRUCTIONS
Bu. I & S Item No.: —
Forces Afloat Mat. Inspection: —
Quar. 19 —
Item No.: —
Ship's Request For Authorization File No.: —
Of: -
Authorizing Reference: ORDALT 2607
Of:
Job Order No.: 110/56
Percent Completion On:
Date Work Started: 2/15/56
Date Completed: 2/22/56
Reported to Bureau via Type Commander: YES 2/23/56
Entered in Mch. Hist. or Office Log.: 2/23/56

Stocked in CDS

232. ORDNANCE ALTERATION CARD, NAVORD FORM 2034

The Current Ship's Maintenance Project (CSMP) record provides data needed for systematic repair and alteration of ordnance equipment. The CSMP record can be useful for the ship force, tender, or shipyard in preparation of work requests. Two cards are used to make up the CSMP: Ordnance Repair Card, NAVORD Form 2033, and Ordnance Alteration Card, NAVORD Form 2034. (These forms are shown in the illustrations on the facing page.)

One of the most important records kept by the weapons department is the ordnance history. This record is kept on NAVORD Form 2032. (NAVORD Form 2032 is shown in the illustration below.)

The ordnance history serves as a record and inventory of each major ordnance equipment aboard ship. A card is made out for each unit of ordnance equipment. Each card shall show all nameplate data (Mk, Mod, and serial numbers, title, location, etc.). Data necessary to keep the ordnance history up to date are obtained from various battery logs. Entries in the ordnance history shall be brief and deal with alterations, major repairs, causes of part failures, modifications, yard jobs, etc.

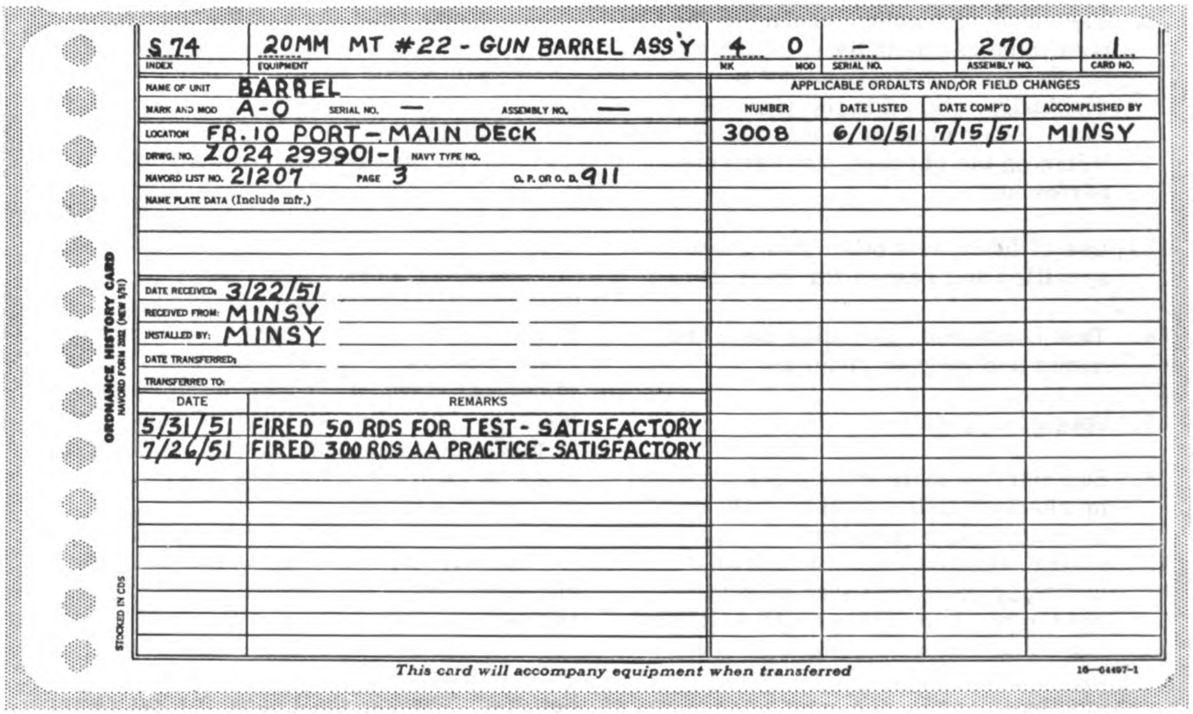
Ordnance history cards are retained onboard ship as long as the equipment remains onboard. If the equipment is transferred, the ordnance history card will accompany the equipment.

There are several types of ordnance logs which are important to a gunner's mate. These logs are the battery log, the small arms log, the magazine temperature record, and the ammunition record.

Methods by which logs can be divided into sections may vary from ship to ship. However, logs are generally divided into three sections which contain the following information:

1. Ordnance history section - nameplate data, special points of interest about operation, records of tests, adjustments, major casualties, all repairs, and overhaul.

2. Table of adjustment section - methods of making adjustments, date



ORDNANCE HISTORY CARD
NAVORD FORM 2032 (NEW 5/51)

INDEX	EQUIPMENT	MK	MOD	SERIAL NO.	ASSEMBLY NO.	CARD NO.
S 74	20MM MT #22 - GUN BARREL ASS'Y	4	0	–	270	1

NAME OF UNIT BARREL
MARK AND MOD A-0 SERIAL NO. — ASSEMBLY NO. —
LOCATION FR. 10 PORT – MAIN DECK
DRWG. NO. 2024 299901-1 NAVY TYPE NO.
NAVORD LIST NO. 21207 PAGE 3 O. P. OR O. D. 911
NAME PLATE DATA (Include mfr.)

DATE RECEIVED: 3/22/51
RECEIVED FROM: MINSY
INSTALLED BY: MINSY
DATE TRANSFERRED:
TRANSFERRED TO:

DATE	REMARKS
5/31/51	FIRED 50 RDS FOR TEST - SATISFACTORY
7/26/51	FIRED 300 RDS AA PRACTICE - SATISFACTORY

APPLICABLE ORDALTS AND/OR FIELD CHANGES

NUMBER	DATE LISTED	DATE COMP'D	ACCOMPLISHED BY
3008	6/10/51	7/15/51	MINSY

STOCKED IN CDS

This card will accompany equipment when transferred

16—64497-1

233. ORDNANCE HISTORY CARD, NAVORD FORM 2032

st adjustments were made, and the set- ig made.

3. Running history section - dates and pes of firing exercises, lubrication, etc.

An ordnance battery log is a chronologi- l record of test, overhaul, repair, altera- on, and maintenance work information out certain ordnance equipment.

A well kept battery log can be used as a sualty reference. If a certain casualty s occurred previously, information about e method used to correct the casualty can found in the log. Also, a new man refer the battery log in order to familiarize mself with a particular battery.

Generally, battery log entries include erything that happens to, is done to, or done with the equipment, except routine eaning.

A list of entries that are made in a ttery log follows:

1. Drills and exercises involving the equipment.
2. Execution of routine, prefiring, and postfiring checkoff lists. Each item on the checkoff list need not be individually entered in the log. However, entry must be made that the items on the checkoff list have been performed.
3. Use of lubricants other than those specified and reason for their use.
4. Test conducted, including measurements and megger readings.
5. Special inspections.
6. Summary of maintenance not covered by checkoff lists, such as addition of hydraulic fluid (quantity and type); filling, flushing, or draining of hydraulic units or water jackets; tightening or checking of all bolts and nuts; and lifting of equipment for inspection, bore sighting, and star gauging.
7. Adverse effects of weather on material operation or maintenance.
8. Detailed description of casualty (name of unit; Mk, Mod, serial, and part numbers of unit and part involved; casualty occurred; probable cause; method of repair; and steps taken to prevent recurrence.
9. Summary of repairs, including complete identification of part or parts affected, parts replaced, and probable cause of failure.
10. Brief summary, including number of any pertinent OrdAlt, ShipAlt, field change, or Bureau authorized modification performed.
11. Report of damage to equipment from an outside source.
12. Record of tram readings, roller path compensator readings, and erosion indicator readings.
13. List of major units or subassemblies of mounts including Mk, Mod, and serial numbers. This list shall be on the first page of the log and is used to properly identify units of equipment.
14. Firing exercises, including quantity, type, and date of rounds fired.
15. Hours of operation of main systems.

The small arms log contains serial numbers of all small arms onboard ship. Entries shall include casualties, modifications, results of inventories, and location of normal stowage. Also, entries shall be made to show when an issue of small arms is made, to whom and for what purpose the issue is made, and the type and amount of ammunition issued.

The ballistics log shows gun ballistic variables which are important both for maintenance and for use by the fire control crew.

A ballistics log is maintained for each battery. The log shall show for each barrel, identified by serial number, the number of rounds fired, star gauge data, bore erosion gauge data, and other data concerning ballistic performance of any gun in the battery.

The magazine temperature log shows the daily temperatures of magazines. When the magazine temperature daily report is made out, one copy of the report is sent to the officer of the deck; another copy is sent to the fire control plotting rooms. From the information on the report, the fire control men compute the initial velocity (I. V.) of any particular gun.

A magazine temperature card is posted in each magazine. Space for recording the maximum and minimum magazine temperatures and for the initials of the individual taking the readings is provided on this card.

A separate section of the magazine temperature log contains the results of the weekly tests of the magazine sprinkling systems and the initials of the person who conducted the tests.

Other records must be kept and other reports made by the weapons department; however, those discussed in this topic are the ones that gunner's mates are mostly concerned with.

> NOTE: When filling out any report, always obtain the necessary information from the particular item the report is to be made on. Do not rely on previous reports for the necessary information.

TOPIC 4: ORDNANCE EQUIPMENT UPKEEP, REPAIR, ALTERATIONS, AND OVERHAUL PERIODS

You Are Now Going to Learn:

1. Definition and importance of upkeep, repair, and alterations of ordnance equipment.
2. Duties of ship force before and during an overhaul period.

Discussion Points for this Topic Are:

1. Definition and importance of upkeep of ordnance equipment.
2. Definition and importance of repair of ordnance equipment.
3. Definition and importance of alterations of ordnance equipment.
4. Types of alterations.
5. Information contained in an OrdAlt.
6. Duties of ship force before and during an overhaul period.
7. Review and summary.
8. Section review.
9. Written test.

INFORMATION AND DISCUSSION:

Upkeep, repairs, alterations, and overhaul are all considered to shipboard maintenance work; however, upkeep is classified as routine or preventive maintenance and includes cleaning, painting, lubricating, exercising, inspecting, and testing.

The importance of proper upkeep of ordnance equipment can never be overstressed. It isn't dramatic or exciting work, neither is there any glamour in a grease gun; however, the daily, weekly, and monthly upkeep has a definite bearing on the amount of future repair and overhaul work.

The Navy considers upkeep so important that it has devised many ways to assist the gunner's mate in his task of maintaining ordnance equipment. Some sources of information to assist the gunner's mate in maintaining equipment follow:

1. All ordnance publications (OP's) on specific parts of ordnance equipment devote part of the text to upkeep.

2. Special ordnance data (OD's) on upkeep of ordnance equipment are often published.

3. Training manuals (bluebooks) almost always devote at least one chapter to maintenance.

4. Lubrication charts are made up for all ordnance equipment. These charts show the lubrication points, list the types of recommended lubricants, and tell how often the lubricant should be applied.

5. Checkoff lists are published by Type Commands. These lists provide a daily, weekly, monthly, and quarterly prefiring and postfiring work schedule which must be adhered to. Items on the lists must be checked off and signed when the work is performed. (A typical postfiring checkoff list is shown in the illustration on the facing page.)

6. Special upkeep and preventive maintenance programs have been and are being devised, to help maintain ordnance equipment. One of these programs is the Programmed Integration System Maintenance (PRISM).

Ordnance repair (corrective maintenance) is defined as work necessary to restore a weapon or a part of ordnance equipment to serviceable condition, without changing the design, material, number, location, or relationship of component parts.

Repairs are divided into three classes according to who will perform the work (ship force, repair ship, or naval shipyard). The ship force is expected to perform all repairs it is able to perform; repair ships

POST-FIRING CHECK OFF LIST

5"/38 TWIN BATTERY

POST FIRING ROUTINE

Step	Mt. 1	Mt. 2	Mt. 3
1. Return live ammunition to magazines			
2. Air, clean, and stow empty brass			
3. Record air pressure in counterrecoil cylinder, differential piston protusion, and length of recoil			
4. Replace safety links			
5. Examine bores and pass bore gage; lap out as necessary			
6. Clean bores with soda; wash out, dry and oil			
7. Overhaul and lubricate firing mechanism			
8. Inspect breech operating cam plate; clean and lubricate breech mechanism			
9. Check boresight and alinement. Record readings			
10. Test recoil liquid			
11. Lubricate mount in accordance with charts			

NAME --

RATE --

All prescribed Post-Firing routines have been carried out. The condition of the battery is satisfactory. The following casualties occurred during firing.

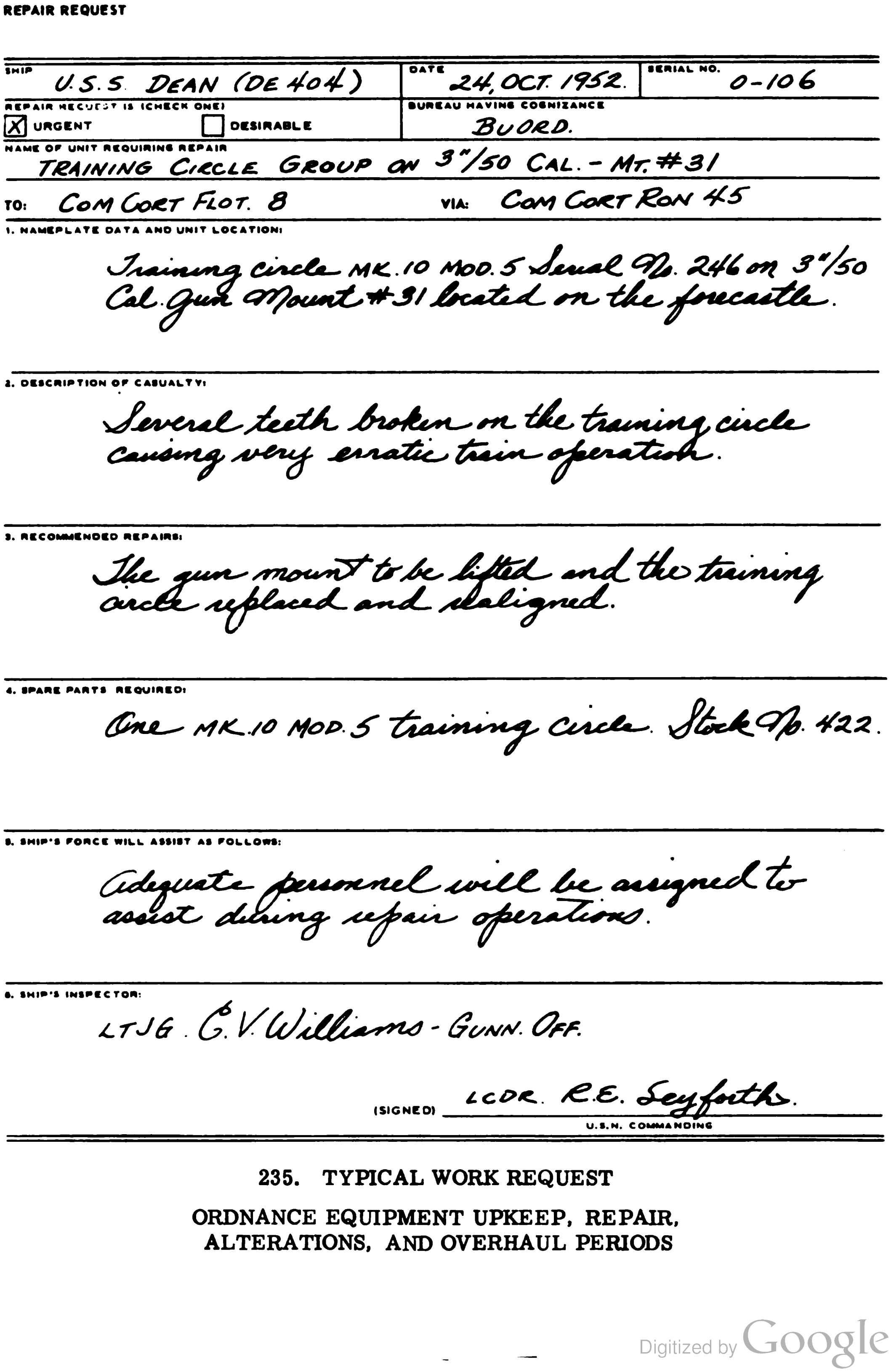
SUBMITTED: ----------------------------------
----------------------------------USN
Gunnery Officer

APPROVED: ----------------------------------
----------------------------------USN
Commanding

234. A TYPICAL POSTFIRING CHECKOFF LIST

and shipyards must perform repairs which are beyond the capacity of the ship force.

When it becomes necessary to request assistance from a repair ship or shipyard, a work request must be submitted. These request forms vary with repair ship and shipyard; however, the basic information required is always the same. (A typical repair request is shown below.)



REPAIR REQUEST

SHIP U.S.S. DEAN (DE 404)	DATE 24, OCT. 1952.	SERIAL NO. 0-106
REPAIR REQUEST IS (CHECK ONE) ☒ URGENT ☐ DESIRABLE	BUREAU HAVING COGNIZANCE BUORD.	

NAME OF UNIT REQUIRING REPAIR
TRAINING CIRCLE GROUP ON 3"/50 CAL. - MT. #31

TO: COM CORT FLOT. 8 VIA: COM CORT RON 45

1. NAMEPLATE DATA AND UNIT LOCATION:
Training circle MK.10 MOD. 5 Serial No. 246 on 3"/50 Cal. Gun Mount #31 located on the forecastle.

2. DESCRIPTION OF CASUALTY:
Several teeth broken on the training circle causing very erratic train operation.

3. RECOMMENDED REPAIRS:
The gun mount to be lifted and the training circle replaced and realigned.

4. SPARE PARTS REQUIRED:
One MK.10 MOD. 5 training circle. Stock No. 422.

5. SHIP'S FORCE WILL ASSIST AS FOLLOWS:
Adequate personnel will be assigned to assist during repair operations.

6. SHIP'S INSPECTOR:
LTJG. C.V. Williams - GUNN. OFF.

(SIGNED) LCDR. R.E. Seyforth.
U.S.N. COMMANDING

235. TYPICAL WORK REQUEST

The required request information should include the following:

1. Ship requesting assistance and date of request.
2. Activity to perform work.
3. Bureau having cognizance of equipment.
4. Priority (emergency, urgent, or routine).
5. Complete outline of work to be performed.
6. Assistance to be furnished by ship force.
7. Signatures of department heads (weapons officer) and commanding officer.

When a repair job has been satisfactorily completed, the information should be entered in the battery log and machinery history.

An alteration is a change to the ship hull, machinery, equipment, or fittings. An alteration involves a change in design, materials, number, location, or relationship of component parts of an assembly. No alteration shall be performed until it has been specifically authorized by the bureau concerned.

Alterations which materially modify the military characteristics of a ship may be authorized only by the Chief of Naval Operations. When such an alteration affects ordnance equipment, authorization is issued by the Bureau of Weapons in the form of a serially numbered NavAlt. Other alterations to ordnance equipment are issued by the Bureau of Weapons as serially numbered OrdAlts.

Alterations to the ship hull are issued by the Bureau of Ships and are called ShipAlts. Hull alterations may also affect ordnance equipment.

An OrdAlt issued by the Bureau of Weapons contains the following information:

1. A clear description of the alteration called for by the OrdAlt.
2. File number and date of the BUWEPS letter which authorized the OrdAlt.
3. Urgency classification (emergency, urgent, or routine). Typical wording of priority classifications are:
    a. "This OrdAlt is classified 'Emergency' and shall be accomplished under the very highest priority."
    b. "This OrdAlt is classified 'Urgent' and shall be accomplished as soon as possible, without causing any delay in the accomplishment of OrdAlts of emergency classification."
    c. "This OrdAlt is classified 'Routine' and should be accomplished as soon as possible, without interference with work of a higher urgency classification."
4. A listing of ships and equipment to which OrdAlt applies.
5. Applicable plans (instructions) for accomplishing the work.
6. Source and supply of material.
7. Allowance list changes and listing of spare parts furnished.
8. Activity which will perform the work.
9. Detailed instructions for accomplishing the work.
10. Test required to insure proper completion.
11. Nomenclature changes.
12. Disposal of replaced material.
13. Change of weight and compensation required.
14. Shipping weight.
15. Reports of completion.
16. Distribution list.

NOTE: These points also apply to NavAlts issued by Bureau of Weapons.

After an OrdAlt has been accomplished, its number should be stamped on the applicable OrdAlt plate (refer to illustration below). Normally, these plates are mounted on equipment that carries a Mk, Mod, and serial number. The accomplished OrdAlt shall also be entered in the battery log and machinery history.

Since certain upkeep, repair, and alteration work is beyond the capability of the ship crew, every ship is periodically scheduled for overhaul alongside a repair ship or in a shipyard.

The preavailability period is the time spent in compiling work orders and preparing to enter a Navy shipyard or repair facility for upkeep and overhaul.

The availabilty period is assigned to a ship by competent authority and is normally scheduled in advance, in accordance with an established cycle, to insure uninterrupted accomplishment of work at a repair facility or activity.

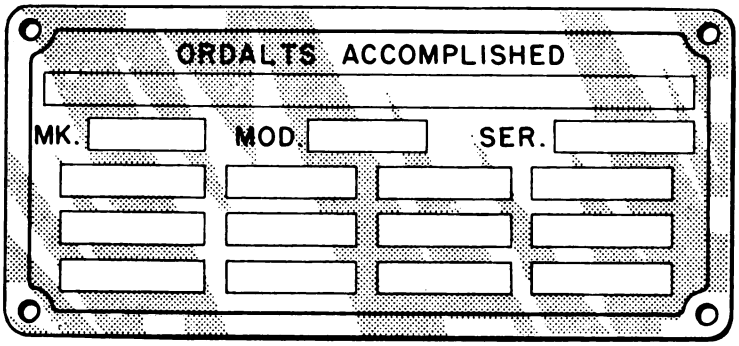
When a ship has been assigned availability in a shipyard, the commanding officer submits a work request for the accomplishment of all repairs beyond the capacity of the ship force. These requests shall be submitted before the ship enters the shipyard.

A list of the work to be performed by the ship force is prepared by the senior man of each division and is submitted to the gunnery officer, outlining the work to be accomplished while the ship is in the shipyard. This list includes such items as cleaning, scraping, and painting; renewing of hydraulic oil; routine greasing; repair of ordnance equipment within the capacity of the ship force; and assisting yard personnel in other ordnance work to be accomplished.

During the yard availability, the ship receives a list of all job orders approved. The ship force assists the yard wherever possible, carrying out the work outlined in the submitted list.

A chart is kept to show the progress of work being performed. Upon completion of the work by the shipyard, the work is inspected and signed for by a member of the ship force.

After the availability period is over, one of the most important jobs is to bring all records up to date. These records include battery logs, machinery history records, gun and mount cards, spare part lists, CSMP cards, and OrdAlt cards. Also, any other records or logs kept by the ship must be corrected to agree with the condition of the equipment after the shipyard overhaul.



236. ORDALT PLATE

ORDNANCE EQUIPMENT UPKEEP, REPAIR, ALTERATIONS, AND OVERHAUL PERIODS

QUIZ SHEET:

1. The supply department on all ships has a central storeroom.

   True__________or False_________.

2. Ordnance equipment records requiring a custody signature are kept on one of the following:

   a. S. and A. Form 1150.
   b. S. and A. Form 488.
   c. S. and A. Form 306.
   d. S. and A. Form 154.

3. The date for the annual ordnance inventory is set by one of the following:

   a. Weapons officer.
   b. Executive officer.
   c. Engineering officer.
   d. Supply officer.

4. S. and A. Form 154 is used as a/an:

   a. Repair parts stock record.
   b. Equipage and custody record.
   c. Survey request, report, and expenditure.
   d. Request for spare parts.

5. Which one of the following Navy bureaus has technical direction of fuel for the Navy?

   a. Bureau of Weapons.
   b. Bureau of Yards and Docks.
   c. Bureau of Ships.
   d. Bureau of Supply and Accounts.

6. The Supply Demand Control Point for the Bureau of Naval Weapons is in OSO, Mechanicsburg, Pa.

   True__________or False_________.

7. List the controlling activities (OSO or BUWEPS) for the ordnance categories known by the following cognizance symbols:

   a. J___________________________.
   b. Z___________________________.
   c. A___________________________.

8. In FSN Z 5330-384-3153, which digits are the class numbers?

   ___________________________________.

9. A gunner's mate may be in charge of ordnance stores on a ship that has central storerooms.

   True__________or False_________.

10. Which one of the following forms is used for request of material from the ship supply department when the FSN cannot be located?

    a. S. and A. Form 1150.
    b. S. and A. Form 302.
    c. DD 1150.
    d. DD 302.

11. Upkeep is the same as corrective maintenance.

    True__________or False_________.

12. A NavAlt pertaining to ordnance equipment is authorized by the Chief of Naval Operations and issued by BUWEPS.

    True__________or False_________.

13. The star gauge report is submitted to BUWEPS on one of the following:

    a. NAVORD Form 154.
    b. NAVORD Form 488.
    c. NAVORD Form 306.
    d. NAVORD Form 54.

14. Training allowance ammunition is not reported to BUWEPS on Form 8015/3 (M).

    True__________or False_________.

15. Ordnance history is kept on one of the following forms:

    a. NAVORD Form 2641.
    b. NAVORD Form 1215.
    c. NAVORD Form 2032.
    d. NAVORD Form 1744.

ORDNANCE EQUIPMENT UPKEEP, REPAIR, ALTERATIONS, AND OVERHAUL PERIODS

16. Daily routine, including cleaning, should be entered in the battery log.

True__________or False_________.

17. When an ordnance report is filled out, the required information should be obtained from a previous report.

True__________or False_________.

Accuracy of notes checked by instructor:

Date______________________________

Trainee's initials______________________

ORDNANCE EQUIPMENT UPKEEP, REPAIR, ALTERATIONS, AND OVERHAUL PERIODS

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